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CLARK FORK DAMAGE ASSESSMENT
BED SEDIMENT SAMPLING AND CHEMICAL ANALYSIS REPORT

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Prepared for:

Natural Resource Damage Program
State of Montana

Prepared by:

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Missoula, MT 59812

October 1992

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EXECUTIVE SUMMARY

As part of the State of Montana's Clark Fork River damage assessment we collected 170 fine bed sediment samples and performed analyses for twelve major and trace metals. These sediments were collected from 111 sites on nine streams in southwest Montana. Two designated 'test' streams were the Clark Fork River and Silver Bow Creek, both within the National Priority List Clark Fork Superfund sites. The other seven streams were termed reference by fisheries consultants and were chosen by these consultants. These reference streams are largely or completely removed from the mining operations at Butte; four are downstream tributaries of the Clark Fork and the other three are streams in adjacent drainage basins.

Fine bed sediments (<63 μm) were sampled because they represent a repository for contaminants and are a direct pathway for contaminants to enter the food chain of fish. In the Clark Fork River system, which we define as the mainstem above Milltown Reservoir plus Silver Bow Creek, much of the fine sediment can be attributed directly to the erosion of streamside mine tailings, and the continued reworking by the Clark Fork River of channel and floodplain deposits which consist largely or in part of tailings originating from mining operations in the headwaters around Butte.

We found the fine sediments in the Clark Fork River system to be greatly enriched in As, Cd, Cu, Pb, and Zn compared to a locally derived baseline. Copper enrichment exceeds *400 fold* above this baseline in Silver Bow Creek and remains 15 fold above baseline 150 miles downstream of Butte. The magnitude and extent of contamination points to large scale mining operations as a source. A dramatic and strikingly consistent downstream trend is found for all five contaminants which provides the evidence of an upstream source. Geochemical ‘fingerprinting’ reveals no significant tributary source of metals other than Silver Bow Creek. Only Silver Bow Creek (which drains the Butte area) can account for more than a inconsequential fraction of the contamination evident in the Clark Fork River sediments.

Together these three lines of evidence—the extreme magnitude and extent of metals enrichment, strong and consistent downstream trends, and geochemical fingerprinting— show that the present metals contamination on the Clark Fork River system could only result from the massive scale mining, milling, and smelting which took place in the headwaters of the Clark Fork River for over one hundred years. These metals would not be present in the extreme concentrations found if not for the mining operations around Butte and Anaconda.

All five metals (As, Cd, Cu, Pb, and Zn) are known to be toxic to aquatic life, cadmium and copper in relatively low concentrations. Cadmium and copper are the two most elevated metals in the Clark Fork River system, both are about seventy fold greater, when compared to reference streams as paired for fisheries population work. We find a strong inverse relation ship between the elevated sediment metals documented by our work, and depressed macro-invertebrate taxa richness and fish populations reported by others for the Clark Fork River system. Others have also documented a positive correlation of sediment metals concentration to the concentration of those metals in aquatic benthos. We present a contamination index, based on recently published sediment biological effects thresholds, which suggests that the primary cause of injury to aquatic life in the Clark Fork River system is copper contamination.

INTRODUCTION

Bed sediments contain significantly higher concentrations—4 to 5 orders of magnitude—of metals and other trace elements than the solute phase (Gibbs, 1977; Martin and Maybeck, 1979; Maybeck and Helmer, 1989), and act as a repository for contaminants as well as a source of contaminants to water and biota (Baudo, Giesy and Muntau, 1990). "Although the amounts of metal mobilized from contaminated sediments may only be a small fraction of total amount accumulated, these small quantities may represent a substantial environmental impact based on their associated bio-accumulation and toxicity characteristics." (Jennett, Effler and Wixson; 1980).

Contaminated bed sediments can adversely affect benthic organisms that live in or ingest sediment (Axtmann, Cain and Luoma, 1990; Luoma, 1989). Fine sediment particles do not depend solely upon interstitial water as a conduit for contaminants entering the biota, such fine particles can adhere to gas exchange membranes of aquatic organisms or be ingested. By such means aquatic organisms can more directly sequester harmful (toxic) constituents from contaminated sediments. Such organisms can then act as a pathway for contaminant transport up the food chain (Moore, Luoma and Peters, 1991). "The concern associated with the chemicals sorbed to sediments is that many commercial species and (human) food chain organisms spend a major portion of their lifecycle living in or on aquatic sediments. *This provides a pathway for these chemicals to be consumed by higher aquatic life* and wildlife, including avian species as well as humans. *Direct transfer of chemicals from sediments to organisms is now considered to be a major route of exposure for many species.*" (Adams, Kimerle and Barnett; 1992, emphasis added). Bed sediment is therefore a "critical path" for ecological effects in large river systems (Tent, 1987).

Previous sediment geochemical work conducted on the Clark Fork River between Warm Springs Ponds and Milltown Reservoir has determined that the bed sediment in the Clark Fork River is highly elevated in metals (Brook and Moore, 1988; Brook, 1988; Andrews, 1987; Axtmann and Luoma, 1991; Axtmann, Cain and Luoma, 1990). Fine-grained, bed sediment represents recent sediment carried by the river—that deposited during the last waning high flow(s). Determining the concentration of metals in bed sediment— a surrogate for suspended sediment—provides a stronger basis for establishing anthropogenic sources of contamination than analyzing dissolved metal loads in water (Horowitz, 1983; Windom et al., 1991). Analyzing bed sediment determines two important aspects of contamination:

i) integration of the concentrations of metals carried by the river during recent high runoff events , and;

ii) the concentrations of metals that benthic insects encounter during their life cycle in the river channel.

These two aspects are the common denominator in injury to biota in river systems.

To ascertain this contaminant pathway in the Clark Fork River system[1], we have established the distribution and sources of metal contamination in fine-grained, bed sediment of the Clark Fork River and determined the geochemical distinctions between contaminated sites and baseline sites. Based on newly acquired data, we discuss:

i) the downstream and basin–wide trends in metals in the Clark Fork River and its main tributaries;

---

[1] For the purpose of this report the Clark Fork River system is taken to include the mainstem above Milltown reservoir and its principal headwaters tributary Silver Bow Creek. Silver Bow Creek contributes about 85% of the annual flow of the Clark Fork River at its origin.

ii) the distribution of metals among study reaches in the Clark Fork River basin;

iii) differences in metal contamination levels between Clark Fork basin fishery study sites and control sites, and;

iv) the potential for toxicity of these sediments to aquatic organisms.

This information is presented to determine the essential connection between metals contamination and injury to fisheries in the basin, and document the source and pathways of contaminant transport from Butte and Anaconda through the Clark Fork River system to Milltown Reservoir.

METHODS

Field Methods

One-hundred-seventy, fine–grained bed sediment samples were collected from 111 sites distributed among 9 streams (Table 1; Appendix A-sampling site maps). Sediment was sampled from the upper Clark Fork River (above Milltown reservoir), five of it's tributaries (Rock Creek, Flint Creek, Gold Creek, Little Blackfoot River, Silver Bow Creek), and three streams in adjacent basins (Bison Creek, Big Hole River, and Ruby River). Streams other than the Clark Fork and Silver Bow Creek were chosen for study by Don Chapman and Associates, as reference in fisheries population work, on the basis of geomorphologic and fish habitat similarities to test reaches in the upper Clark Fork River and Silver Bow Creek. Sediment sampling sites were selected on the basis of accessibility to stream, distribution along the reach of stream sampled, and comparability with the fish population sample sites. Fifty five Clark Fork sites were sampled over 115 miles of river from Milltown reservoir upstream to

Table 1
Distribution and types of sediment samples collected.

Stream	Code	# samples	# sites	# splits	# of reps
Bison Creek	BC	11	6	1	4
Big Hole R.	BH	19	12	1	6
Clark Fork R.	CF	75	55	5	15
Flint Creek	FC	7	3	0	4
Gold Creek	GC	5	3	0	2
Little Blackfoot R.	LB	5	3	0	2
Rock Creek	RC	12	6	0	6
Ruby River	RR	14	10	0	4
Silver Bow Creek	SB	22	13	2	7
	Total	170	111	9	50

just below Warm Springs Ponds. All sediment samples were collected over an eight week period in October and November of 1991. The location of each sample was described in a field notebook and marked on a USGS 7.5 minute quadrangle (Appendix A). Sample sites are identified by a two character stream code and samples assigned a sequential number within a stream, chronologically, as sampled; these designations are used throughout this report (Table 1).

The sediment sampling apparatus consists of a 15 cm diameter two piece plastic Buchner funnel fitted with a sheet of 63 µm nylon mesh screen about 30 cm square, and a large plastic spoon. Stream bed sediment was carefully scooped from backwaters and shallows wherever fine sediment had settled. Several scoops were loaded into the funnel and the less than 63µm fraction sieved through the mesh into a 250 ml wide mouth polyethylene bottle. Additional scoops of sediment were collected until the bottle was full to the neck with a slurry of sediment. Samples were composited over a 15-30 m stretch of stream bottom at each site.

All sample bottles were acid washed, rinsed several times with de–ionized water, and allowed to dry before use. Sampling apparatus was also acid washed before each use. Plastic gloves were worn by sampling personnel during sample collection. Field quality control involved collection of fifteen rinsate blanks, fifteen bottle blanks, nine field splits, and 25 sites sampled in replicate. At least one bottle and rinsate blank were collected on each sampling trip. Replicates[2] were taken from the same 15-30 m stretch of stream. These were denoted by a sample name suffix of X, Y, or Z, except that the X is absent in the case were a previously sampled site was revisited for replicate sampling.

---

[2] Although the QAPP required only that duplicates be taken often triplicate samples were collected.

Field splits are identified with a suffix of A or B (Appendix B). Samples were labeled in the field with their sample name, location, date, time, and name of sampler and then sealed with chain of custody seals and placed on ice in a cooler for transport back to the lab. A chain of custody form was completed for each sample in the field. Upon return to the laboratory sediment samples were centrifuged at 1800-2000 rpm for 15 minutes then the supernatant was decanted and discarded. The sample bottles with their cake of de–watered sediment were placed in an oven to dry at 70°C for at least 24 hours before being removed to a desiccator and stored for later digestion. The oven door was sealed with evidence tape for the duration of drying, and the desiccator was stored in a locked cabinet. All operations were recorded in a notebook. Except for sub–samples of fourteen sample digests sent off to an independent laboratory for referee analysis, at no time did any of the samples or their preparations leave the custody of lab personnel.

Lab Methods

De-ionized water used for digestions and standards preparation was polished with a Milli-Q purification system. "Trace Metal Grade" acids were used for digestion. SPEX stock solutions were used to prepare standardization solutions, spike solution, and interelement check samples. All labware was acid washed by soaking in 50% HCl for at least 1 hour followed by multiple rinsings with de-ionized water.

Sample Digestion

In order to determine the metals content of the sediments they were digested using an aqua-regia microwave method and the diluted digest analyzed by Inductively Coupled Argon Plasma (ICAP) emission spectroscopy for Al, As, Ca, Cd, Cu, Fe, Mg, Mn, Ni, P, Pb, and Zn. The State of Montana Clark Fork Damage Assessment QAPP was followed for the contract analytes Cd, Cu, Fe, Mn, Pb, and Zn; in addition As was given the full QA/QC treatment. The other analytes, by virtue of simultaneous analysis, were subject to all the QA/QC protocols of As and the contract analytes except that they were not present in the spike.

In order to randomly select samples for duplication and spiking, a list of sample names was entered into a spreadsheet and an adjacent column of random numbers was created. This list was sorted using the random numbers as the key, from the sorted list the top 10 samples were designated for duplicate digestion and the next 10 were designated to receive the pre-digestion spike.

Next, the original sample list was sorted such that reference streams and tributaries appeared in alphanumeric order followed by Clark Fork samples sorted in upstream order, then the SB samples in alphanumeric order again. This ordering of samples was chosen for analysis to minimize potential for cross contamination resulting from intermixing samples of high analyte concentration with those of low analyte concentration. Results from earlier work (Brook and Moore, 1988; Axtmann and Luoma, 1991) lead us to expect that Clark Fork and Silver Bow Creek sediments would be elevated in metals with an increasing gradient upstream. This list was then broken into 10 groups of seventeen samples each. To each group was added a method blank, a Standard Reference Material (USGS SED2), a laboratory duplicate sample, and a spiked sample, making 21 samples per digestion group. This expanded list was then serially numbered and the prefix CFDA added to arrive at unique lab numbers for the 210 samples to be digested.

A spike solution was prepared from SPEX standards such that addition of 330 µl would result in a final concentration in the digest of 1 ppm for As & Cu, 0.1 ppm for Cd, 2 ppm for Fe & Mn, and 0.5 ppm for Pb with a nominal dilution of 1:100[3]. The digestion vessels and centrifuge tubes employed were numbered from 1 to 21. Lab identification, field sample name, vessel/tube number, sample weight, and diluted digest weight were recorded on a lab sheet—one sheet per digestion batch.

Method Development

Mineral acids have long been employed by analytical chemists to bring solid samples into solution for analysis. The EPA (Plumb, 1981) published a aqua-regia digestion method for sewage sludge based on the works of Delfino and Enderson (1978), and Delfino, Bortelson, and Lee (1969). Digestion of sediments by HNO_3/HCL mixture has been found to produce accurate and precise analysis of minor and trace elements (Caravajal, et al. 1983). Previous work has indicated microwave digestion to be a suitable technique for dissolution of geologic materials (Matthes, et al, 1983, Nadkarni, 1984, Brooks, 1988).

Although use of aqua-regia alone does not result in total digestion of silicate minerals, digestion of standard reference materials performed in our laboratory (Table 2) and the work of others (Brooks, 1988, Caravajal et al., 1983) show that this method does achieve nearly complete recovery of contaminant metals. The combination of acid used, acid volume, sample weight and organic matter content, digestion vessel volume, and rate and duration of microwave energy applied all affect maximum temperatures and pressures achieved during digestion (Kingston and Jassie, 1988). We modified earlier methodology by using larger digestion vessels, half the acid volume, a greater sample weight,

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[3] Therefore the spike values are equivalent to a sediment concentration a hundred-fold greater given a nominal 500.0 mg sample digested and then diluted to 50.00g.

Table 2
Digestion Method Test - 2-17-92

USGS SED2

Analyte		Measured Value mean, n=5	Spike Recovery n=1	Reported Value	% Recovery
ppm	Al	6346		8800	72
	As	161	103%	144	112
	Ca	17480		17000	103
	Cd	7.6	105	8.3	92
	Cu	1173	97	1100	107
	Fe	20460		22800	90
	Mg	4736		5200	91
	Mn	1568	84	1500	105
	Ni	9.9		10.8	92
	P	758		nd	—
	Pb	149	106	149	100
	Zn	1512	108	1500	101

NBS 2704

Analyte		Measured Value mean, n=5	Spike Recovery n=1	Reported Value	% Recovery
ppm	Al	9988		61100	16
	As	23.1	103	23.4	99
	Ca	23820		26000	92
	Cd	2.1	102	3.4	62
	Cu	94.9	100	98.6	96
	Fe	30360		41100	74
	Mg	8434		12000	70
	Mn	473	101	555	85
	Ni	34.5		44.1	78
	P	903		998	90
	Pb	161	98	161	100
	Zn	401	97	438	92

Contract analytes appear in **boldface** and half the final dilution. These modifications were made in part to reduce possibility for digestion vessel over-pressurization and in part to gain better detection of analytes in the sediments. Savillex Corp. (#578) 120 ml Teflon digestion vessels were employed; their tops come fitted with an adjustable pressure relief valve. These vessels are rated to a maximum pressure of 100 PSI with the adjustable relief valve at its tightest setting. In the event of over-pressurization, the relief valve vents through a piece of teflon tube which can be immersed in a neutralizing solution. To check for leakage resulting from over-pressurization of the vessels, the free end of each vent tube was submersed in a 5 ml vial containing a dilute solution of NaOH (1 drop 1.0N NaOH in 250 ml de-ionized water) and a few drops of phenolphthalein. Digestion times, micro-wave power, and acid volume, were adjusted during trial runs until no venting occurred and analysis of reference materials showed complete recovery of metals (Table 2).

In preparation for digestion, the dried sediment cakes were ground in their collection bottle utilizing a thick glass rod which was washed and dried between samples. Ground samples were then placed back in a desiccator over-night before weighing. Nominal 0.5 gram sub-samples were weighed directly into tared 120 ml Teflon digestion vessels (Savillex Corp. #578) and the actual mass recorded to 0.1 mg. A spike of 330 µl was added to the sample designated to be spiked, an equal volume of de-ionized water was added to all other vessels. Open vessels were covered with a sheet of paper to keep out dust and allowed to sit for at least 30 minutes. After 30 minutes, 1.25 ml HNO_3 and 3.75 ml of HCl were added to each vessel. Samples tended to form a lump, so each vessel was individually swirled until the entire sample was suspended, then all were allowed to pre-digest at room temperature with tops loosely affixed.

After another 30 minutes for pre-digestion, tops were tightened with a plastic wrench supplied by the manufacturer for that purpose. Sealed vessels were placed on the bottom of a plastic cake saver and arranged with their vent tubes in a vial of dilute NaOH with phenolphthalein. The cake saver top was placed over the vessels and the whole container placed in a General Electric Dual Wave microwave oven on a carousel. In each corner of the oven was placed a 250 ml bottle of cold tap water to balance the microwave load (Kingston and Jassie, 1988). Samples were heated at full power (575 watts measured) for 6 minutes while rotating at 1/2 revolution per minute. Vessels were allowed to cool at least 15 minutes before opening. While cooling they were checked for signs of leakage (i.e.. neutralization of solution in vent tube vial); no leakage was noted in any of the digestions performed for this project.

Cooled digests were transferred to polypropylene centrifuge tubes with multiple washings of de-ionized water. Next the digests were diluted with de-ionized water to a nominal mass of 50 grams; the actual mass was recorded to 0.01 gram. Diluted digest solutions were then centrifuged at 2600 RPM for 5 minutes to settle digestion residue and decanted into 100 ml plastic bottles labeled with the corresponding lab identification number. These solutions were kept in locked storage for later instrumental analysis.

ICAP Analysis

Quantification of analyte concentrations in the digests was performed using a Thermo Jarrell-Ash (TJA) Atom Comp 865 ICP interfaced to a PC running Thermo-Spec software (TJA model 61 equivalent). The instrument was standardized at the beginning of each day of operation using two point standardization and a suite of four multi-element matrix-matched standard solutions prepared from SPEX stock standards. Interelement corrections and background corrections were programmed into the ICAP method and handled by the TJA software. Prior to analysis of any digests, linearity of instrument response was verified on Feb. 17th, 1992 and limits of detection (three times the standard deviation of 10 replicate exposures of the standardization blank) were determined on Feb. 18th, 1992. Limits of detection were also determined more rigorously as three times the standard deviation of 10 analyses of method blanks run concurrently with sample digests over four separate analysis dates. A comparison of these limits of detection with project required limits appears in table 3. Instrument detection limits translate to a detection limit in the sediment one hundred fold greater as a consequence of the 1:100 nominal dilution from sediment to digest.

All analyses consisted of three consecutive 7 second exposures which were averaged to produce one analytical result; only these analytical averages are reported. QAPP protocol was met or exceeded for all analyses performed for this project. Sample analyses were bracketed by continuing calibration checks using the standardization blank and a composite standard analyzed at least every 20 samples. Method blanks were run at the greater frequency of not more than once every 10 samples and also bracketing all samples runs. Interelement check solutions were analyzed at least once each day. Raw data and QA/QC summary appear in Appendix B and C respectively. A schematic diagram of sample analysis sequence and a list of samples in their order of analysis appears in Appendix D.

Carbon Analyses

Total carbon and inorganic carbon in fine-grained, bed sediment was determined using a Columetrics' Model 5120 Total Carbon Apparatus, and a Columetrics' Model 5130 Acidification Module for Carbonate Carbon. Samples

Table 3
Limits of Detection

Analyte	PDL	IDL_a	IDL_b
Al	200	30	20
As	30	30	30
Ca	5000	6	70
Cd	20	4	3
Cu	25	2	10
Fe	100	3	40
Mg	5000	30	80
Mn	15	2	1
Ni	40	9	6
P	—	60	90
Pb	35	40	20
Zn	20	3	3

PDL = project requirements, IDL_a = ICP Detection limits determined Feb. 18th, 1992, IDL_b = ICP Detection Limits determined from method blanks. Concentrations in units of µg/l (ppb). Contract analytes appear in **boldface**.

were oven dried at 70°C and stored in a desiccator prior to analyses. A pre-weighed sub-sample was introduced into the combustion chamber at 1050°C via platinum boat and the total carbon read after 6-8 minutes when the reading stabilized. For determination of inorganic carbon, a sub-sample was treated with 3 ml of 2N H_2SO_4 in the Acidification Module. Sample weights above 400 mg were treated with 4 ml acid to assure all of the sediment was digested. A uniform heat setting of 5 was used, and 3% $AgNO_3$ scrubber, acidified to pH 3, was used to remove common product gases. Analysis time ran from 7-8 minutes, until a stabilized reading was obtained. Scrubber solutions for both apparatus were changed when blanks were above manufacturer suggested values, when the analysis ran over 9 minutes, or when the solutions appeared exhausted (began to foam excessively).

Blanks and standards were run every day, at beginning and end of the analysis procedure, to check accuracy of results. Blank values for total carbon analyses ranged from 0 to 20 µg C for all analytical runs, and for inorganic carbon analyses blank values from 0 to 10 µg C were obtained; within the manufacturers specifications.

Primary standard grade calcium carbonate, and NBS 2704 standard reference material, were used for determination of the accuracy and precision of measurements. Relative standard deviation for analysis of standards were within ± 3% of stated or calculated standard values for total carbon, and within ± 2% for inorganic carbon. The mean total carbon (TC) and total inorganic carbon (TIC) analyses of calcium carbonate were 12.00% (n=48) and 12.11% (n=36) respectively, the nominal value for both analyses is 12.00%. For NBS 2704 the means were 3.35% (TC) and 0.89% (TIC), n=34 and 29 respectively, the reported value for TC is 3.36% and for TIC there is no reported value.

Triplicate analyses of the same sample were run after every nine samples; triplicate analyses showed a relative standard deviation of 0.5% to 6.6% for TC analyses, and 0.2% to 11.0% for TIC analyses. The relatively large variation in sample RSD for TIC, as compared to RSD for the standards, is a function of the low TIC in many of the samples.

Organic carbon was calculated by difference between total carbon and inorganic carbon. All carbon data appear in Appendix E.

Data Processing

Sediment digest raw ICP data were exported to an ASCII file and transferred to a Macintosh computer where results for all analytes were adjusted for sample and solution masses to arrive at concentrations in the sediment on a dry weight basis. Method blank data were below limits of detection for all but a few cases in which blanks were run after samples of high analyte concentration. In all these cases, the blank was an insignificant fraction of the sample reading.

Sample readings were below detection limits only for Cd in Ruby River, Rock Creek, and one Gold Creek Site. Averages below the limit of detection are reported as being less than this limit. For data calculations involving below detection data these values were replaced with zero or the limit of detection, whichever would be most conservative. When displayed graphically, below limit of detection data are plotted as the analytical values obtained with the limit of detection also plotted for comparison, except that any negative values are plotted as zero.

For graphical analysis, data from all 170 samples were used. Descriptive and other statistical treatments of the data used a reduced data set of 111 data points resulting from replacement of field splits and replicates by their respective averages. Each sample site on the Clark Fork river was assigned a river mileage based on distance (measured on USGS quads) from the nearest tabulated milepoint in the River Mile Index: Clark Fork Pend Oreille River (Pacific Northwest River Basins Commission, 1976). Silver Bow Creek sites were similarly given a mileage by measured extrapolation from uppermost Clark Fork milepoint of 490.4 miles (at the former confluence of Silver Bow and Willow Creeks). For the purposes of data analysis we choose a subset of the fisheries reference streams as a geochemical control based on known mining history and comparison to average sediment chemistry reported in the literature.

RESULTS AND DISCUSSION

Determining Geochemical Baseline Concentrations

To establish the extent of metal contamination in bed sediments of the Clark Fork River requires comparison to natural levels of metal content—the geochemical baseline (Förstner and Wittmann, 1981). Comparing the metal content of bed sediments to average crustal values for different geologic material (Table 4) can be a "quick and practical means of tracing high metal enrichments which may constitute a source of dangerous environmental pollution..." (Förstner and Wittmann, 1981, p. 135). However, because sites of large-scale mining activities are commonly associated with naturally higher concentrations of metals in the environment, local baseline values should be used to ascertain the level of contamination (Förstner and Wittmann, 1981). Stream processes in drainage basins with little or no mining activity composite the local geochemical terrain during transport and deposition of sediment. Analysis of bed sediment from such tributaries establishes the local geochemical baseline concentration. Once established, the geochemical baseline can be used to determine "enrichment factors" for metals (Förstner and Wittmann, 1981). We used such comparisons to determine the extent and magnitude of contamination in the Clark Fork River basin.

Baseline can also be established based on biologic considerations—indicator species or communities (Mudroch et al., 1986). Streams little affected by large-scale contamination, with similar habitat, geomorphic and geologic framework to the contaminated stream, can be used as reference for biologic components (e.g., fisheries). Metal concentrations can then be compared between the "reference" (baseline) and the "test" (contaminated) streams to determine the level of contamination in the test stream.

Establishment of geochemical baseline in the Clark Fork Basin is difficult because of the widespread distribution of mining in the region (USGS, 1963; Lange, 1977) and the widespread waste deposits from the mines and smelters of the Butte-Anaconda region (Moore and Luoma, 1990). Drainage basins for all the streams sampled for this project have been mined to some extent. Silver Bow Creek in the Butte district is the site of greatest metal production in the state of Montana. Through 1964, Butte produced 16,188,000,000 pounds of copper, 4,793,000,000 pounds of zinc, 837,000,000 pounds of lead, 318,000,000 pounds of arsenic, and 4,075,000 pounds of cadmium (Meyer et al., 1968). By 1900, Butte had yielded 40 percent of the total U.S. production of copper (Freeman, 1900). Anaconda, on another headwater tributary of the Clark Fork, was the site of the largest-scale milling and smelting. Airfall contamination from that smelter complex extends for at least a 20 mile radius (Brick and Moore, 1992) away from the site. This broad distribution of contamination, potentially adds metals to the entire headwaters of the Clark Fork and the Big Hole and Missouri rivers drainages to the south and east. Although not as well documented, smelting at Butte also added a large burden of metals to soils that likely extends into surrounding drainage basins, such as Bison Creek.

Other tributaries of the Clark Fork River also were mined, although not at the scale of Butte-Anaconda. The Flint Creek drainage was the site of extensive hardrock mining of large silver, lead and zinc deposits in the Phillipsburg district (USGS, 1963; Earll, 1972; Lange 1977); both gold and manganese were also recovered from these deposits. Gold Creek was the site of the first gold discovery in Montana, and its' placer deposits supplied gold until the late 1940's (USGS, 1963; Wolle, 1963). Mining for gold, silver, copper, silver and lead was active both north and south of the Little Blackfoot River; mostly be-

Table 4
Average Elemental Abundances for Some Earth Materials

		Soil[1]	Sediment[2]	Shale[3]	Granite[3]	Crust[4]
%	Al	7.1	7.2	8.0	8.2	9.5
	Ca	1.5	6.6	2.2	2.5	5.4
	Fe	4.0	4.1	4.7	3.0	5.8
	Mg	.50	1.4	1.5	.94	2.1
ppm	**As**	6.0	7.7	13	1.9	1.5 [5]
	Cd	.35	.17	.22	.13	.11 [5]
	Cu	30	33	45	30	60
	Mn	1000	770	850	540	1100
	Ni	50	52	68	15	30
	P	800	670	700	920	1000. [5]
	Pb	35	19	20	15	14. [5]
	Zn	90	95	95	60	75. [5]

[1] Bowen (1979), soil values are medians of data compiled from literature

[2] Bowen (1979) after Wedepohl (1968)

[3] Turekian and Wedepohl (1961), high calcium granite.

[4] Taylor (1979)

[5] Bowen (1979)

fore 1875, but placer mining extended into 1954 (USGS, 1963). Only Rock Creek, of the tributaries sampled in the Clark Fork basin, has survived with only a minimal amount of mining activity (Lange, 1977).

Outside the Clark Fork River basin, other drainages sampled were also affected by mining to some extent. Bison Creek lies only three miles from Butte, just east of the Continental divide, and likely received airfall contaminants from the early smelters at Butte. Some tributaries of the Big Hole River also lie within the radius of suspected airfall contamination from the Anaconda Smelter. As well, mining produced significant amounts of copper, gold, silver, lead, and zinc from tributaries in both the Pioneer and Highland mountains upstream from the sampling reach on the Big Hole River (Lange, 1977; USGS, 1963). Alder Gulch, a tributary of the Ruby River, was the site of the richest placer gold deposits in Montana (USGS, 1963; Wolle, 1963). Therefore, all "reference" streams in the Clark Fork River basin and adjacent basins have been mined to some extent, so that metals input to stream sediment has now become part of the baseline metal concentrations. So if anything these seven reference streams together are a conservative, or under, estimate of geochemical baseline

With mining activity so prevalent throughout the region, it is unlikely that the fisheries reference streams have been unaffected and actually reflect pre-mining conditions. With this limitation and the absence of data on pre–mining conditions, we utilize a combination of tributaries with a minimum of mining activity and compare them to average crustal abundances. Average values from the literature for sediment, shale, granite, and the earth's crust are quite similar to one another when comparing the 13 elements analyzed in this report (Table 4). Most elements vary by less than a factor of two; only arsenic varies by more than a factor of five among these four materials. When the average sediment

Table 5
CFDA Sediment Results - Analyte MEANS by Stream

		BC[1]	BH	RR	RC	FC	GC	LB	CF	SB	L.O.D.
%	Al	1.33	.97	.90	.70	.82	1.21	.92	.91	1.17	*.0002*
	Ca	.89	1.45	7.16	.62	2.19	1.61	1.48	4.35	1.07	*.0007*
	Fe	3.75	2.15	1.43	1.10	1.33	1.54	1.66	1.72	3.66	*.0004*
	Mg	.51	.56	.91	.37	.55	.54	.48	.56	.41	*.0008*
	n=	***6***	***12***	***10***	***6***	***3***	***3***	***3***	***55***	***13***	
ppm	As	90.7	25.5	8.1	8.1	184	4.7	25.2	94.5	605	*3*
	Cd	.52	<.3	<.3	<.3	1.87	<.3	.73	6.10	34.0	*.3*
	Cu	112	31.4	20.0	11.0	66.9	27.8	56.3	908	9170	*1*
	Mn	1700	1800	540	379	2820	858	2040	3940	2300	*.1*
	Ni	10.2	11.6	15.6	7.5	8.0	12.6	15.5	12.2	12.2	*.6*
	P	1480	1500	943	1280	1130	1380	1670	1340	4380	*9*
	Pb	46.7	76.4	15.9	11.1	256	19.3	61.7	137	1510	*2*
	Zn	382	156	59.5	36.7	711.7	73.3	171	1284	8800	*.3*

Mean element concentrations in fine (<63µm) sediment on a dry weight basis computed from data set of 111 *sites* (field splits and replicates replaced with their averages). SB-1 exculdes 1 data point from site below former origin of Clark Fork River. L.O.D. = Limits of determination in sediment based on IDL_b (see methods section). n= number of sites.

[1] Refer to table 1 in methods

concentrations for the streams in this study (Table 5) are compared to crustal values, only the Ruby River, Rock Creek, and Gold Creek are found to have sediment analyses which are near the average concentrations in Table 4; these streams have also had a minimal impact from hardrock mining. The other six streams all have sediments with one or more of the potential contaminants As, Cd, Cu, Pb, and Zn present at a concentration more than twice that of the high value found in table 4 (Table 6).

Table 6
Streams With Sediment As, Cd, Cu, Pb or Zn Above Baseline

Stream	Contaminants
Bison Creek	As,Cd,Pb,Zn
Big Hole River	As,Pb
Clark Fork River	As,Cd,Cu,Pb,Zn
Flint Creek	As,Cd,Pb,Zn
Little Blackfoot River	As,Cd,Pb,Zn
Silver Bow Creek	As,Cd,Cu,Pb,Zn

Therefore, we consider the Ruby River, Rock Creek and Gold Creek to be our local geochemical reference for sediments, and from these three streams we compute a local baseline average sediment concentration (Table 7). For comparison to other stream sediments, Table 7a lists values from nine western United States rivers.

Sediment Analytical Results

Differences and similarities among the streams can be easily seen by examining the data graphically. We use boxplots to visually represent the central tendency of the data in each stream as well as the degree of variability. The

Table 7
Local Sediment Baseline Elemental Abundances

		Ruby River	Rock Creek	Gold Creek	O(x,`) RR, RC,GC[1]
%	Al	(.90)[2]	(.70)	(1.21)	(.94)
	Ca	7.16	.62	1.61	3.13
	Fe	1.43	1.10	1.54	1.36
	Mg	.91	.37	.54	.61
ppm	As	8.1	8.1	4.7	7.0
	Cd	<.3	<.3	<.3	.223
	Cu	20	11	28	20
	Mn	540	379	858	592
	Ni	15.6	7.5	12.6	11.9
	P	943	1280	1380	1200
	Pb	15.9	11.1	19.3	15.4
	Zn	59.5	36.7	73.3	56.5

Contaminant metals appear in boldface.

[1] These values are used as baseline or 'background' in this report.

[2] Values in parentheses indicate analytical result is low due to digestion method employed, see methods section for discussion.

[3] Because all three local streams were below l.o.d. , we used the value for shale in Table 4.

Table 7a

Elemental concentrations of western United States sediments

(from Severson et al., 1987[1])
(Total metal concentrations in less than 63 micrometer bed sediment)

	As (ppm)	Cd (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)
Tulare Lake, CA.[1]	7.4	NR	33	14.2	99
Salton Sea, CA.[1]	6.1	NR	35	24.9	115
Sun River, MT[1]	8.7	NR	31.2	17.3	112
Milk River, MT[1]	6.3	NR	35.6	15.7	86.4
Laguna Atascosa, TX[1]	6.7	NR	26.3	22.4	81.9
Middle Green, UT[1]	5.8	NR	19.4	16.3	74.4
Lower Colorado, AZ[1]	7.5	NR	29.8	23	72
Kendrick, WY[1]	7.0	NR	17.7	18.3	79.22
Stillwater WMA, NV[1]	12.5	NR	35.9	21.5	82.5
Mean	7.6	-	29.3	19.3	89.2
Std. Dev.	2.0	-	6.8	3.7	15.8

Table 7a (continued)

	Al (wt. %)	Ca (wt. %)	Fe (wt. %)	Mn (ppm)	Mg (wt. %)
Tulare Lake, CA.[1]	8.5	2.9	3.42	588	1.7
Salton Sea, CA.[1]	7.1	5.5	3.40	853	1.8
Sun River, MT[1]	8.5	3.4	2.85	298	2.4
Milk River, MT[1]	5.9	2.2	2.84	423	1.6
Laguna Atascosa, TX[1]	6.2	8.8	2.76	729	1.7
Middle Green, UT[1]	5.2	9.8	2.06	530	1.4
Lower Colorado, AZ[1]	6.1	8.9	3.29	869	1.6
Kendrick, WY[1]	5.6	4.5	2.25	451	1.3
Stillwater WMA, NV[1]	7.0	5.2	3.56	869	1.9
Mean	6.7	5.7	2.94	623	1.7
Std. Dev.	1.2	2.8	.53	215	.3

Table 8
CFDA Sediment Results - Analyte MEDIANS by Stream

	BC[1]	BH	RR	RC	FC	GC	LB	CF$_l$	CF$_m$	CF$_u$	SB
% Al	1.31	.98	.91	.66	.83	1.13	.92	.80	.94	.97	1.16
Ca	.90	1.10	7.35	.62	2.04	1.82	1.34	5.21	3.59	4.32	.83
Fe	3.58	2.09	1.46	1.02	1.35	1.49	1.57	1.33	1.64	2.05	3.70
Mg	.53	.51	.94	.32	.55	.51	.48	.47	.53	.61	.38
n=	***6***	***12***	***10***	***6***	***3***	***3***	***3***	***17***	***19***	***19***	***13***
ppm As	74.8	24.7	7.5	7.9	198	4.8	26.4	50.3	63.2	142	543
Cd	.4	<.3	<.3	<.3	1.7	<.3	.7	4.3	5.5	7.7	34.7
Cu	114	30.5	20.1	11.0	64.8	26.9	52.1	502	785	1302	9000
Mn	1630	1000	528	386	2700	878	1780	1763	3010	4900	2060
Ni	9.7	11.8	16.4	6.9	8.3	11.2	15.4	10.4	12.5	13.9	12.7
P	1480	1490	940	1300	1100	1200	1610	1260	1390	1400	4410
Pb	46.5	69.3	14.7	9.5	258	18.0	65.6	93.0	116	176	1530
Zn	355	154	59.0	36.0	720	68.0	165	1020	1173	1573	8880

Median element concentrations in fine (<63µm) sediment on a dry weight basis computed from data set of 111 *sites* (field splits and replicates replaced with their averages). Clark Fork River data subdivided into three groups. n= number of sites.

[1] Refer to table 1 in methods

middle line in a boxplot represents the median of the data (Table 8 lists median sediment metal concentrations). The top and bottom of the box represent the 25th and 75th percentiles of the data, enclosing 50% of the measured values. The "whiskers", which may extend from the boxes, represent the 10th and 90th percentiles, enclosing 80% of the measured values. If the data set is small, there may be no distinction between the ends of the box and extent of the whiskers.

For graphical presentation of results, the Clark Fork River data were subdivided into three divisions of approximately equal numbers of samples. The, lower division (CFl) extends from Milltown Reservoir to about Rattler Gulch, the middle division (CF_m) from Rattler Gulch to just below Garrison Jct., and the upper division (CF_u) extends upstream from Garrison Jct. (Table 9). This was done to reveal upstream changes in Clark Fork metals concentrations which is evident from an examination of site data when ordered by stream mile; an observation consistent with previous work (Axtmann and Luoma, 1991, Brook and Moore, 1988).

Boxplots for As & Pb, Cu & Zn, Cd & Ni, and Fe & Mn are presented in figures 1 through 4 respectively. The pairing of elements in these figures is intentional and based on similarities in the patterns of differences among stream and stream segments. The scale of the y axis varies with element as no one scale would adequately accommodate all.

Table 9
Breakdown of Clark Fork Data into Three Groups

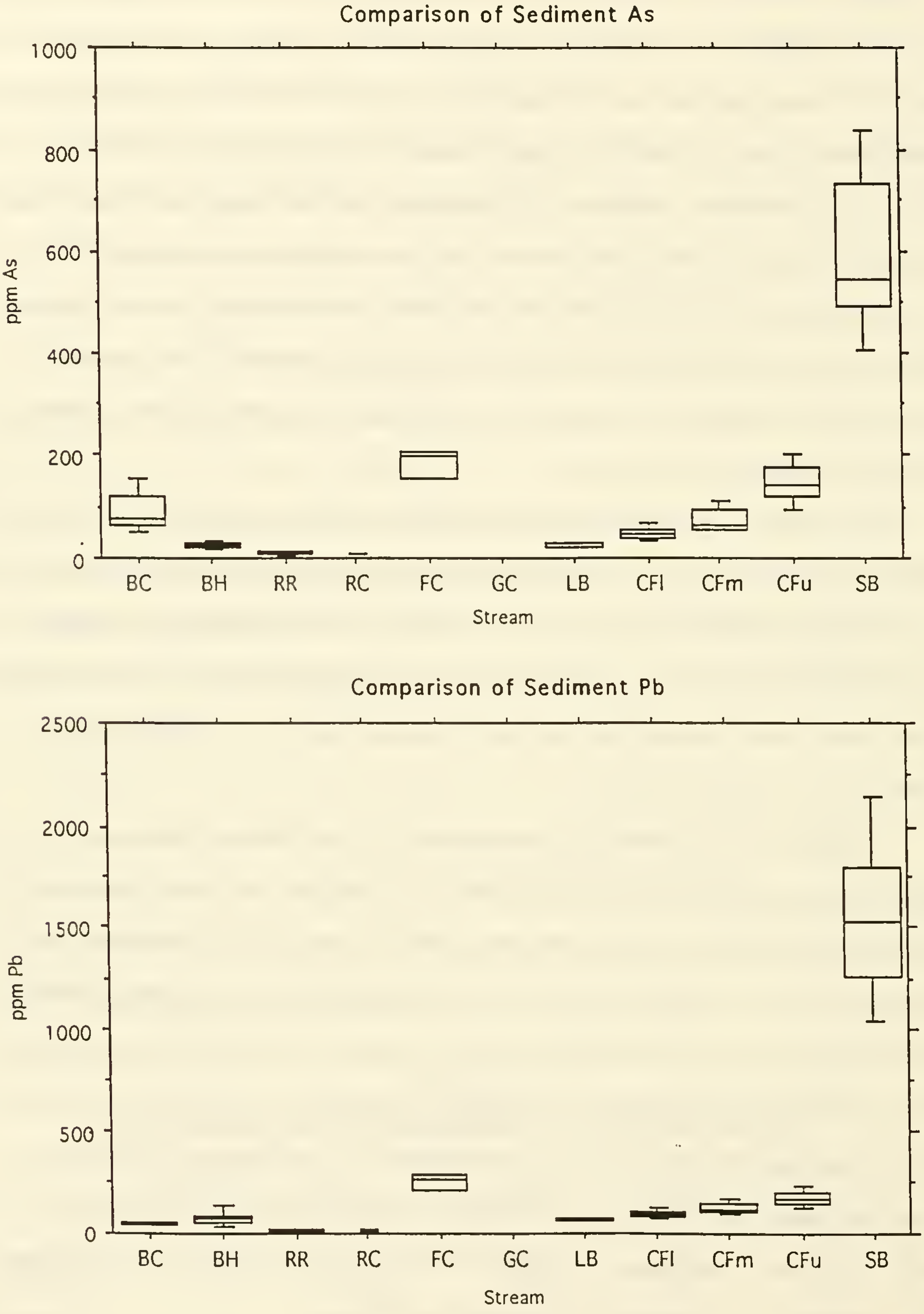
	CF_l	CF_m	CF_u	Total
samples	25	26	24	75
sites	17	19	19	55
mile begin	367.6	410	444.5	115.8
mile end	409.6	444	483.4	

Plots for As, Cd, Cu, Pb, and Zn all illustrate a distinct elevation above baseline in sediment concentrations in the Clark Fork River and Silver Bow Creek. To a lesser degree, one or more of these same five contaminants appear elevated in sediments from Flint Creek, Bison Creek, Little Blackfoot River, and the Big Hole River. However, Silver Bow Creek and the Clark Fork River sediments stand out in contrast to the others, particularly with regard to Cu. Not surprisingly, only Gold Creek, Rock Creek, and the Ruby River sediments are relatively uncontaminated. On the other hand, plots for Fe, Mn, and Ni show a similarity among the streams more typical of baseline variation little affected by anthropogenic inputs.

The trends for arsenic and lead in the sediments of these streams are strikingly similar (Figure 1), with the exception that lead in Bison Creek is more near the baseline than is arsenic. In the Clark Fork subgroups, both arsenic and lead show a clear stair-step increase up to the very elevated levels in Silver Bow Creek—nearest the centers of mining activity. The stair–step is more pronounced for arsenic.

Copper, zinc (Figure 2), and cadmium (Figure 3) also exhibit similar patterns. These, however, differ somewhat from arsenic and lead. Bison and Flint Creeks are not as elevated for these three contaminants as they are for arsenic and lead. Copper (Figure 2) is the most elevated contaminant in the Clark Fork River and Silver Bow Creek, all other streams are essentially indistinguishable from the baseline for copper. Although Flint Creek is affected by mining and has elevated metals concentrations in its sediments, it stands out from the Clark Fork River and Silver Bow Creek in that it is not elevated in copper. The stair-step pattern in Clark Fork subgroups noted for arsenic and lead is also evident for cadmium, copper, and zinc.

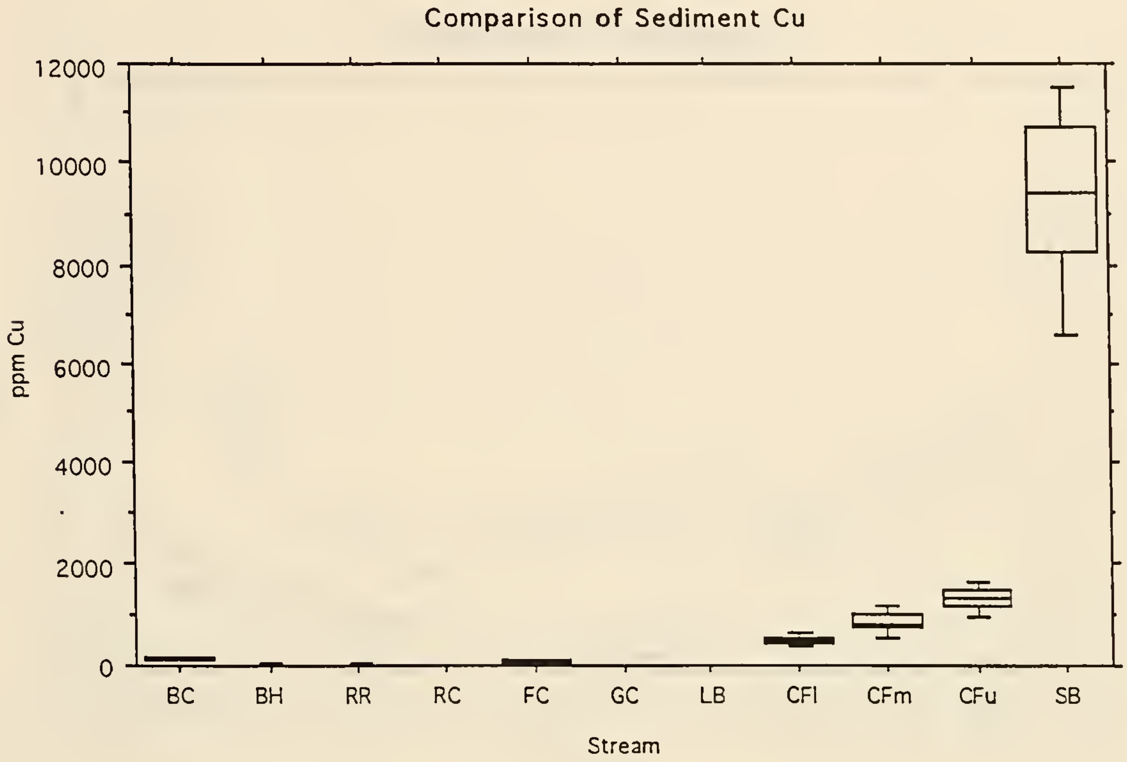
Nickel (bottom half Figure 3), in contrast to the suite of five elements



Comparison of Sediment As

Comparison of Sediment Pb

Figure 1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4000
2000
0
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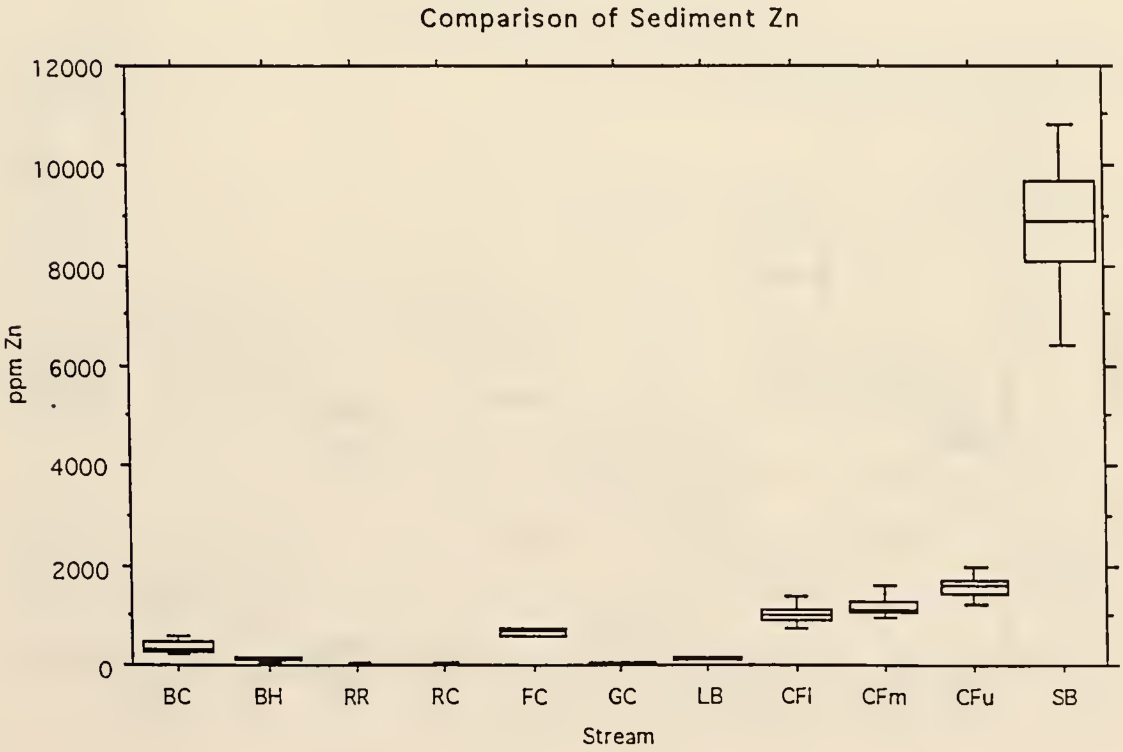
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream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BC
BH
RR
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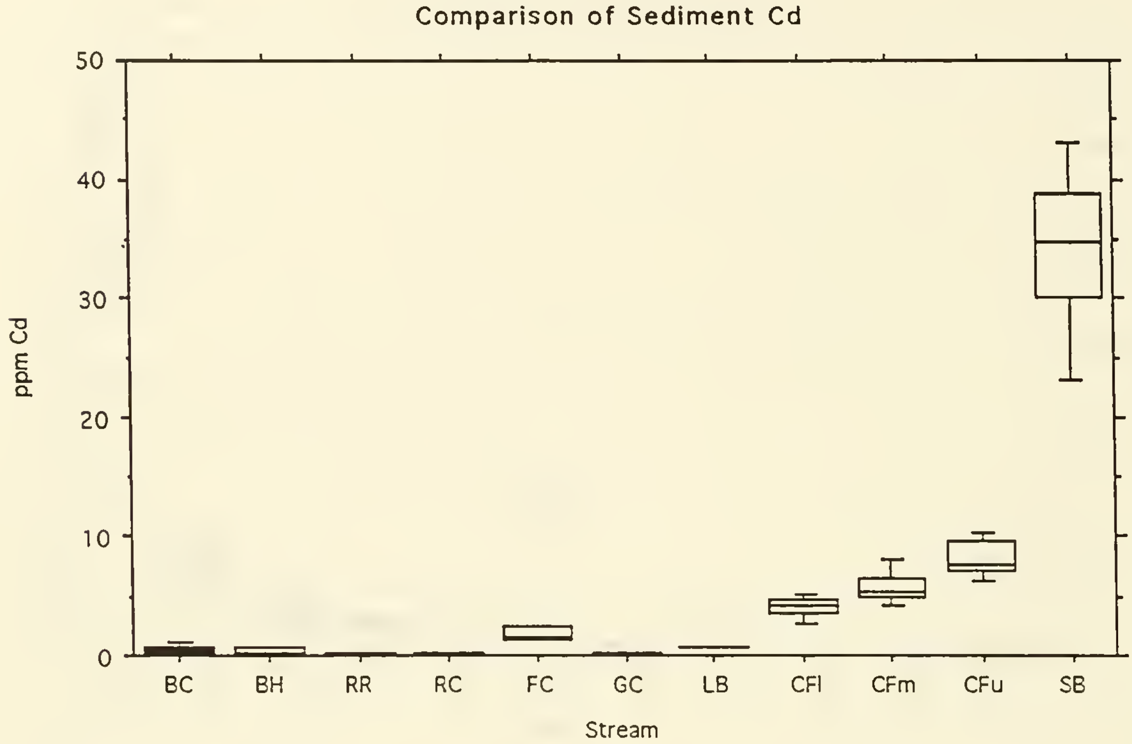
FC
GC
LB
CFl
CFm
CFu
SB
Stream

Figure 2


Comparison of Sediment Cd
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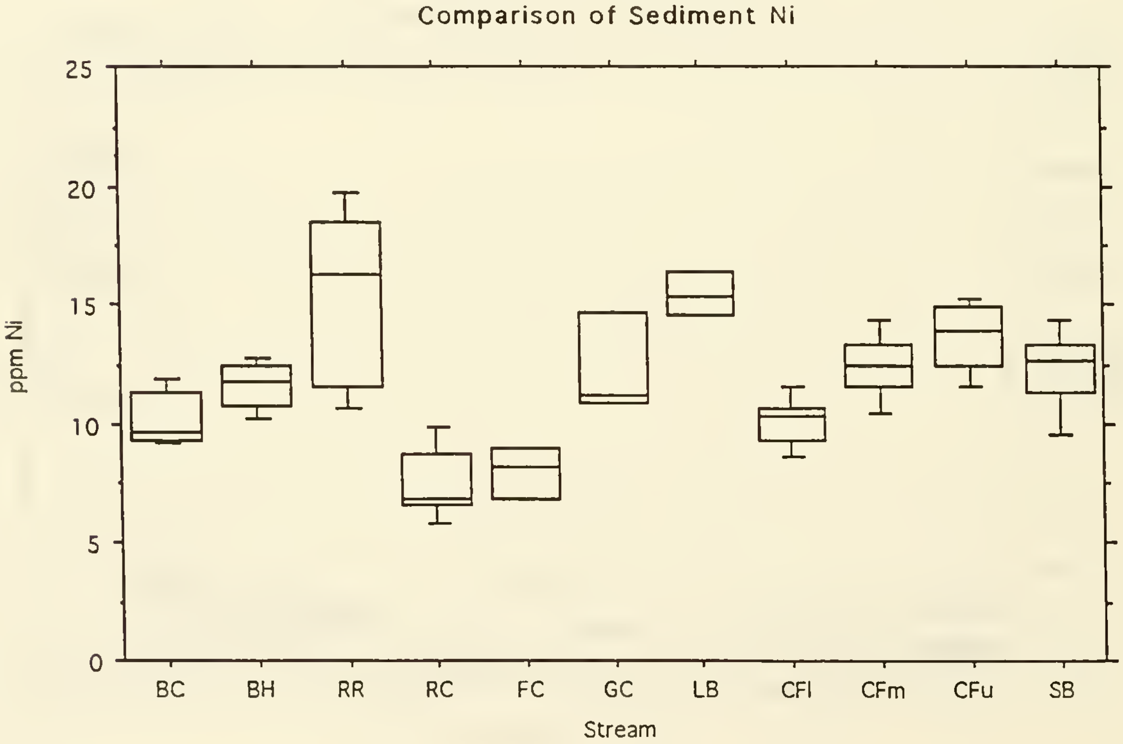
40
30
20
10
0
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream


Comparison of Sediment Ni
ppm Ni
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20
15
10
5
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BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

Figure 3

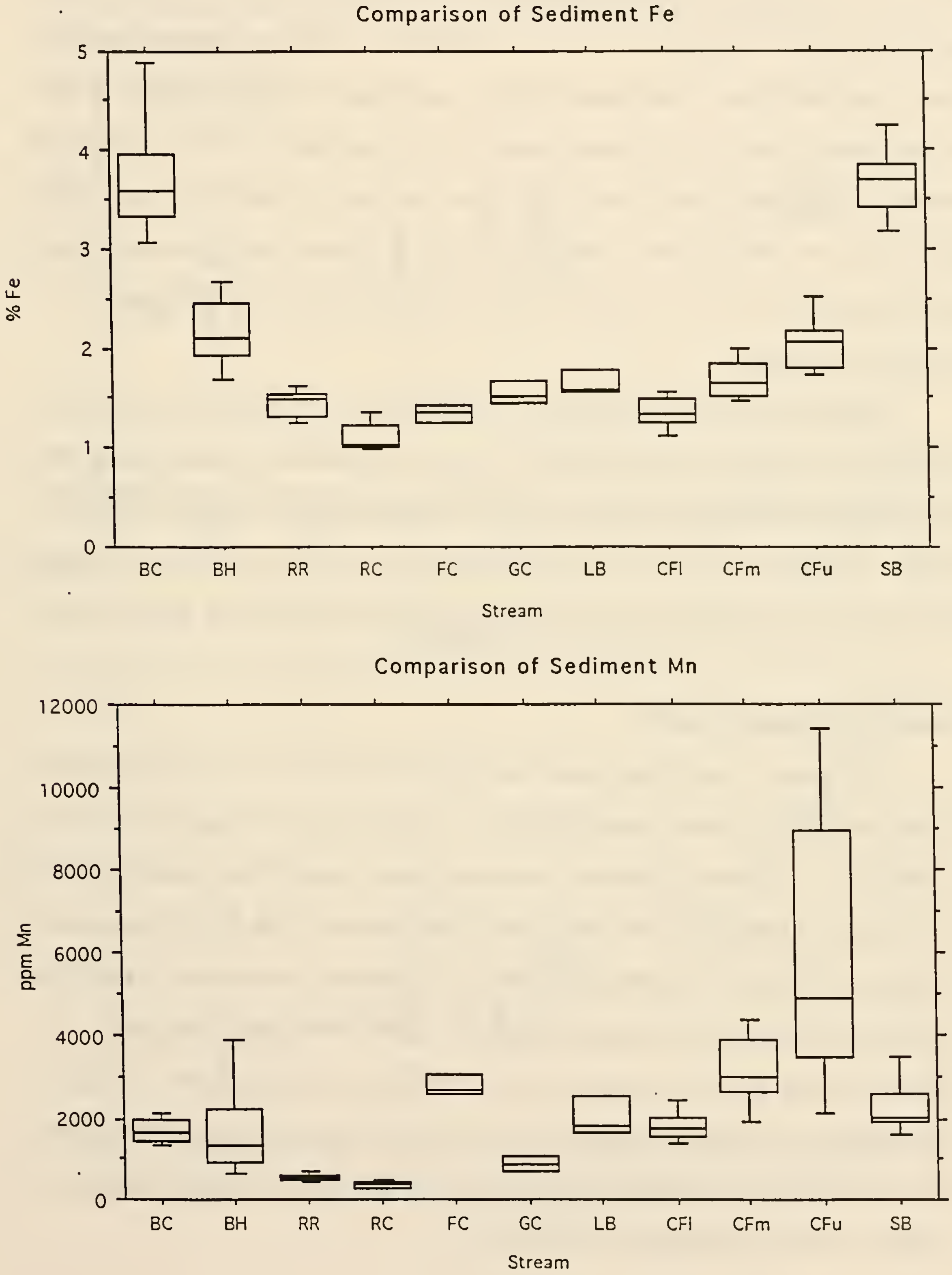

Comparison of Sediment Fe
% Fe
0
1
2
3
4
5
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream
Comparison of Sediment Mn
ppm Mn
0
2000
4000
6000
8000
10000
12000
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

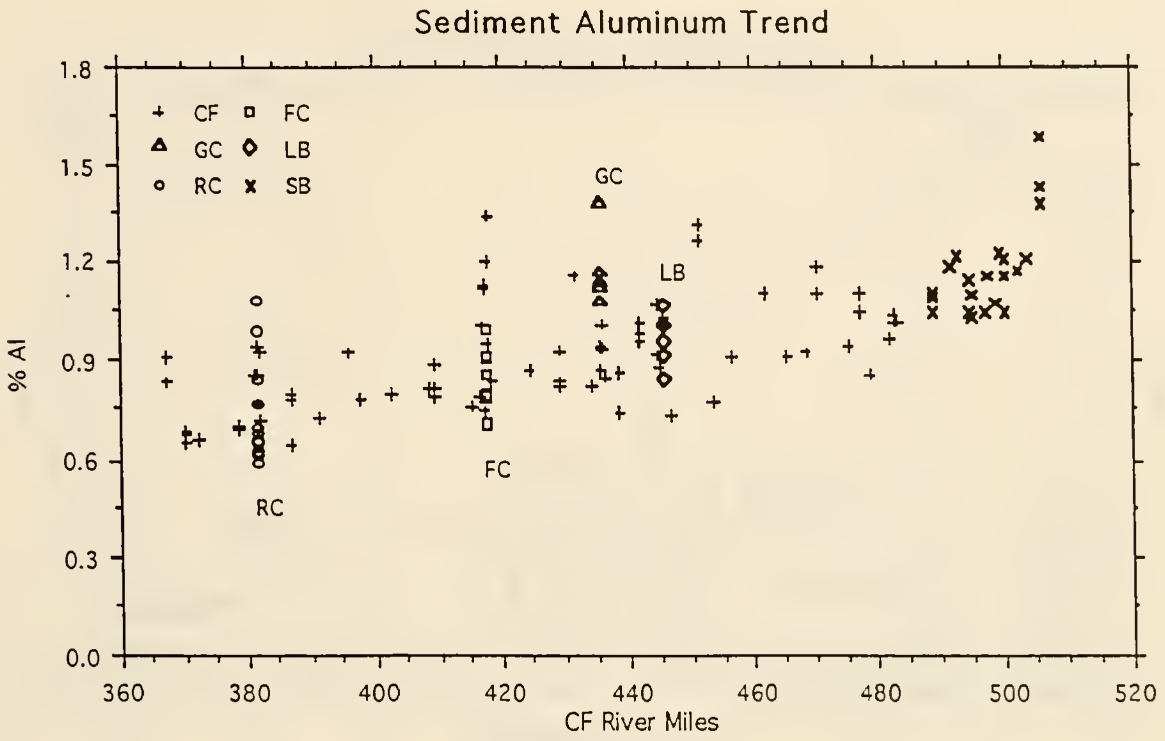
Figure 4

above, shows considerable consistency in sediment concentrations among study streams. The average Ni concentration for all sites is 12.1 ppm, very near our baseline value of 11.9 ppm. The plot of Fe (Figure 4) displays the similarity in Silver Bow and Bison Creek expected in consideration of their common headwaters. Streams sharing a common headwaters often share similar geology and weathering regimes. This is true of the upper reaches of Bison Creek and Silver Bow Creek, on this basis they might be expected to have had similar bed sediment chemistry for trace as well as major elements prior to the differential impacts of mining.

Manganese (Figure 4) displays a high degree of variability with some indication of elevated concentrations in streams impacted by mining (Big Hole River, Clark Fork River, Flint Creek, Little Blackfoot River, and Silver Bow Creek). Unlike any of the previously discussed analytes, manganese is highest in the upper two segments of the Clark Fork River, not in Silver Bow Creek.

Clark Fork Basin Trends

The range in sediment metal concentrations found in the Clark Fork and Silver Bow creek is quite large (Table 10). This is due, in a small part, to local variability in sediment. However, when sediment metal concentrations from the six streams in the Clark Fork basin are plotted versus Clark Fork River miles (Figures 5-10), it can be seen that a major component to variation in these data are basinwide trends in sediment chemistry within the Clark Fork basin. To construct these plots, all sample sites in a tributary were given the mileage of the confluence of that tributary with the Clark Fork River, Silver Bow Creek sites were assigned mileage based on map measurement from the highest tabulated Clark Fork milepoint (see methods).


Sediment Aluminum Trend
% Al
1.8
1.5
1.2
0.9
0.6
0.3
0.0
+ CF
□ FC
△ GC
◇ LB
○ RC
× SB
GC
LB
FC
RC
360
380
400
420
440
460
480
500
520
CF River Miles

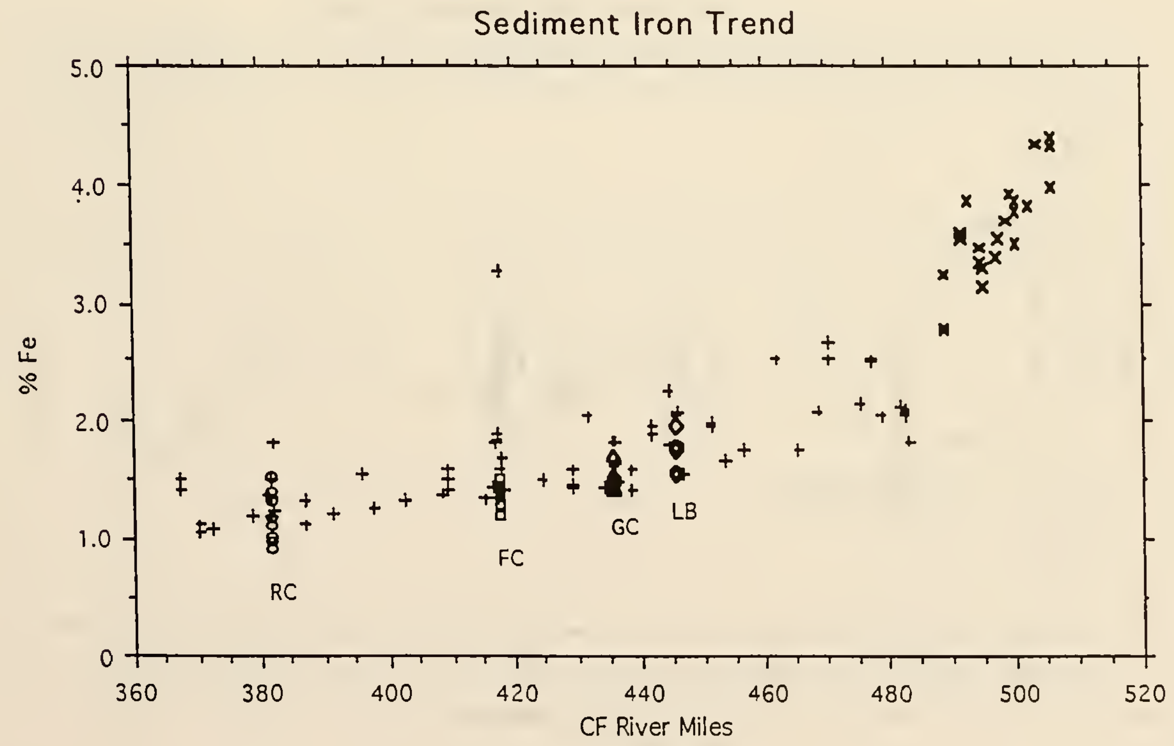
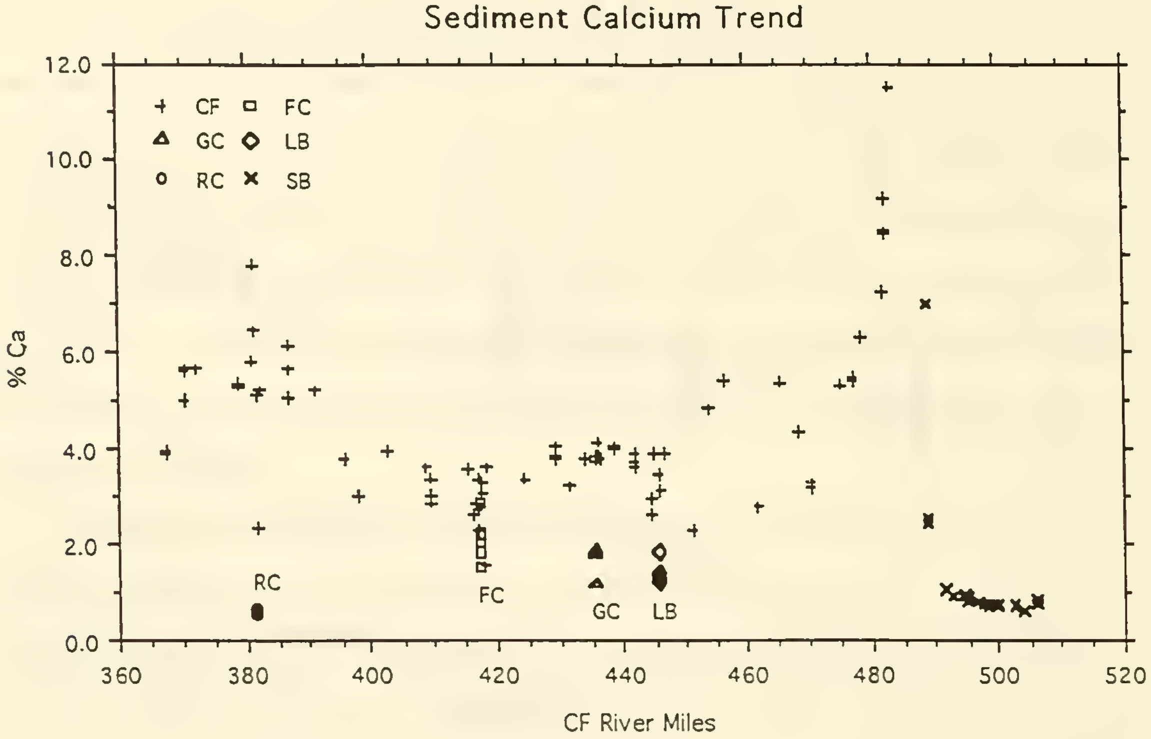

Sediment Iron Trend
% Fe
5.0
4.0
3.0
2.0
1.0
0
LB
GC
FC
RC
360
380
400
420
440
460
480
500
520
CF River Miles

Figure 5


Sediment Calcium Trend
% Ca
12.0
10.0
8.0
6.0
4.0
2.0
0.0
CF
FC
GC
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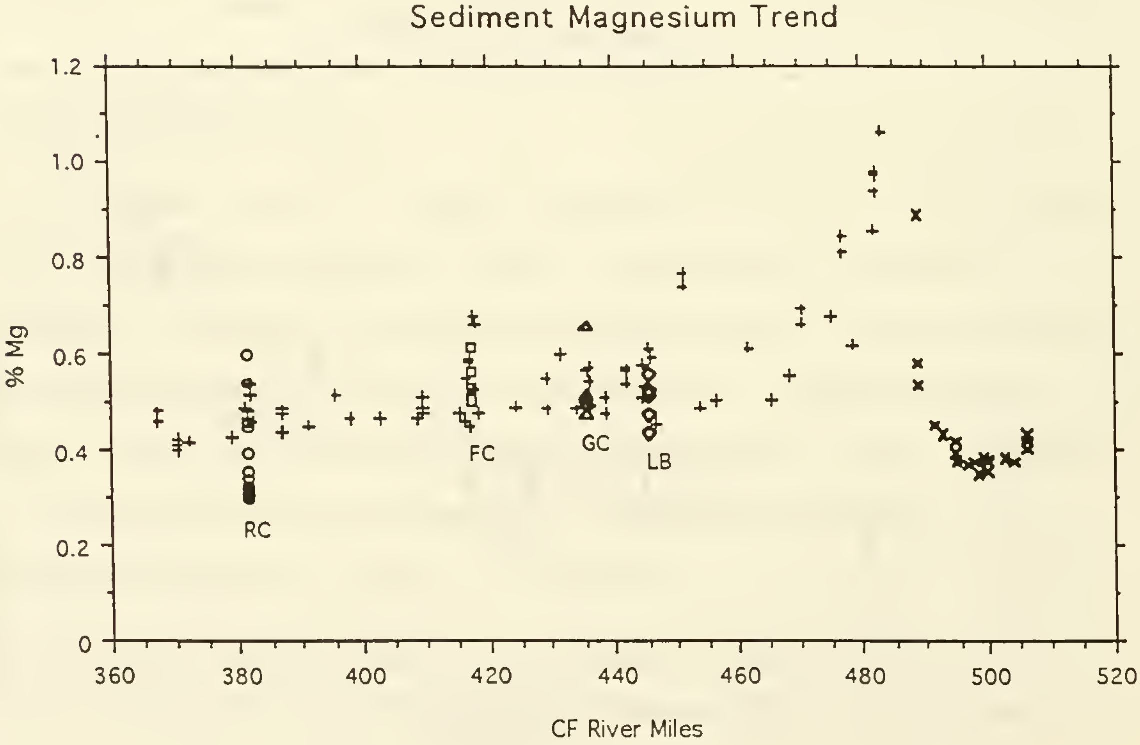
440
460
480
500
520
CF River Miles


Sediment Magnesium Trend
% Mg
1.2
1.0
0.8
0.6
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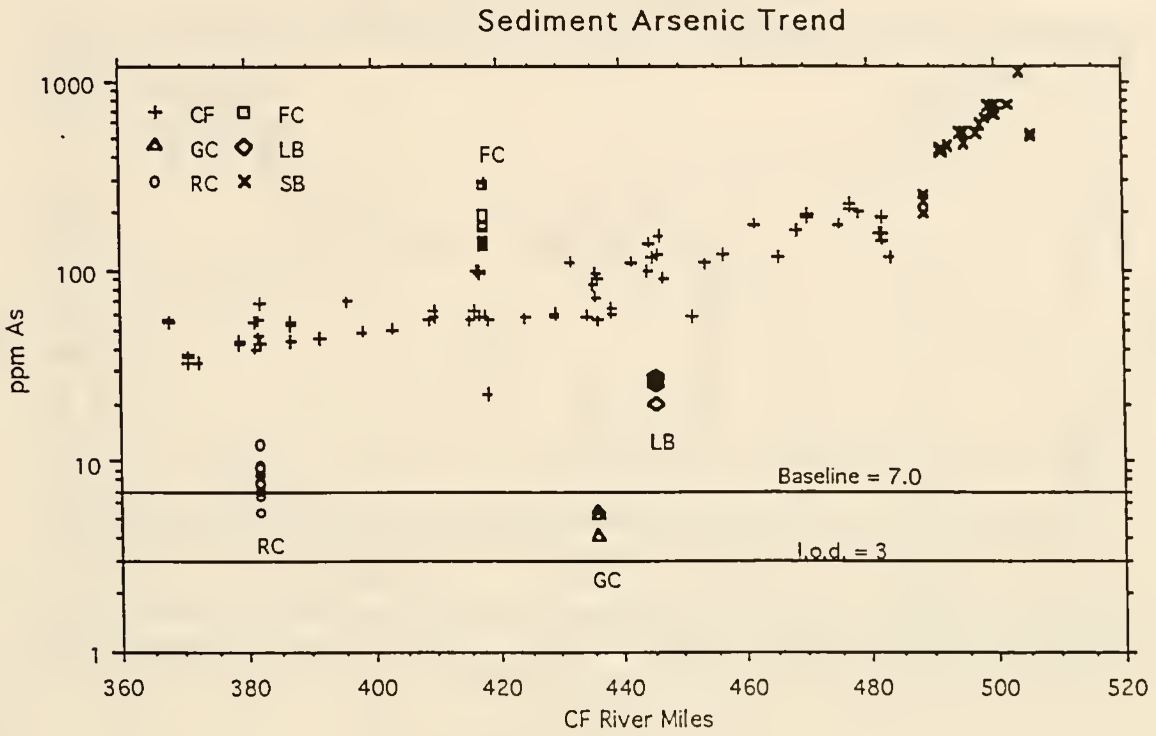
0
RC
FC
GC
LB
360
380
400
420
440
460
480
500
520
CF River Miles

Figure 6


Sediment Arsenic Trend
ppm As
1000
100
10
1
+ CF
□ FC
△ GC
◇ LB
o RC
× SB
FC
LB
RC
GC
Baseline = 7.0
l.o.d. = 3
360
380
400
420
440
460
480
500
520
CF River Miles

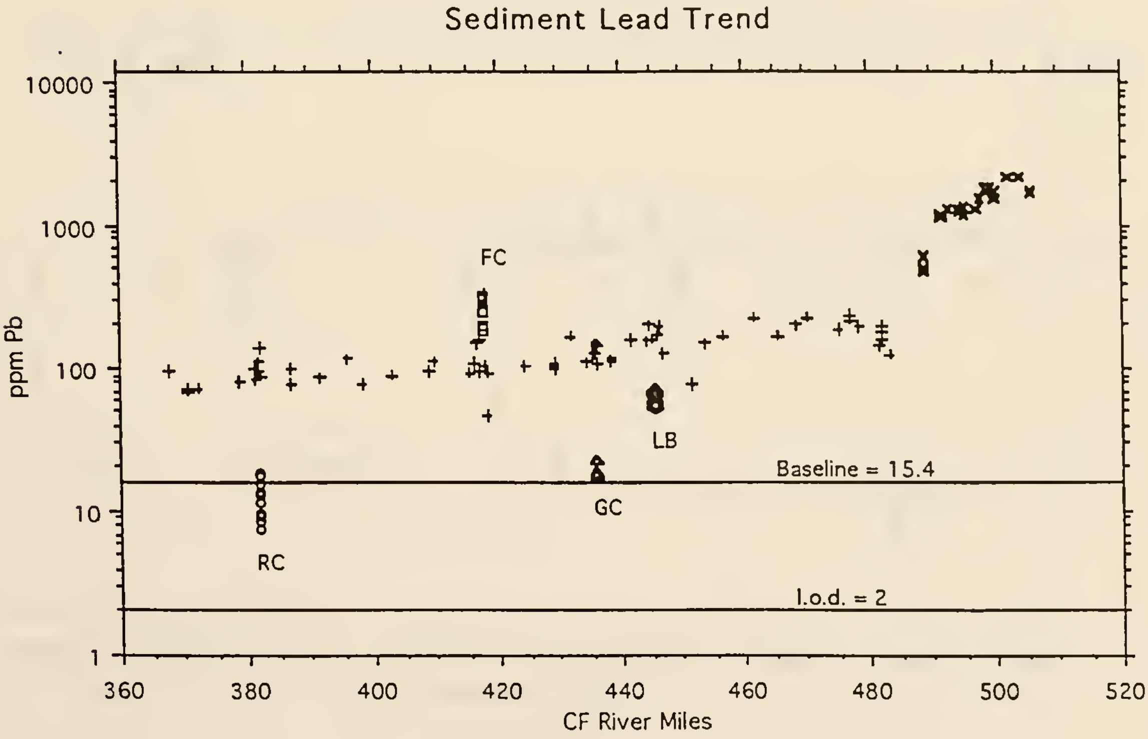
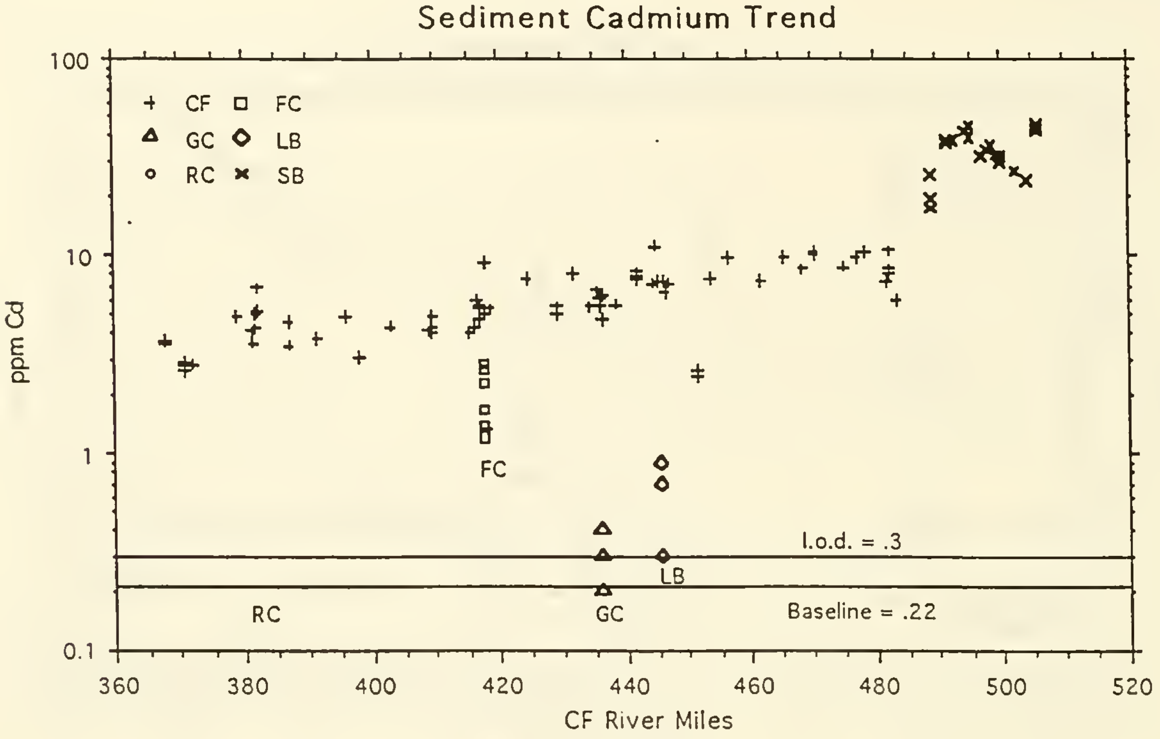

Sediment Lead Trend
ppm Pb
10000
1000
100
10
1
FC
LB
GC
RC
Baseline = 15.4
l.o.d. = 2
360
380
400
420
440
460
480
500
520
CF River Miles

Figure 7


Sediment Cadmium Trend
ppm Cd
CF River Miles
100
10
1
0.1
360
380
400
420
440
460
480
500
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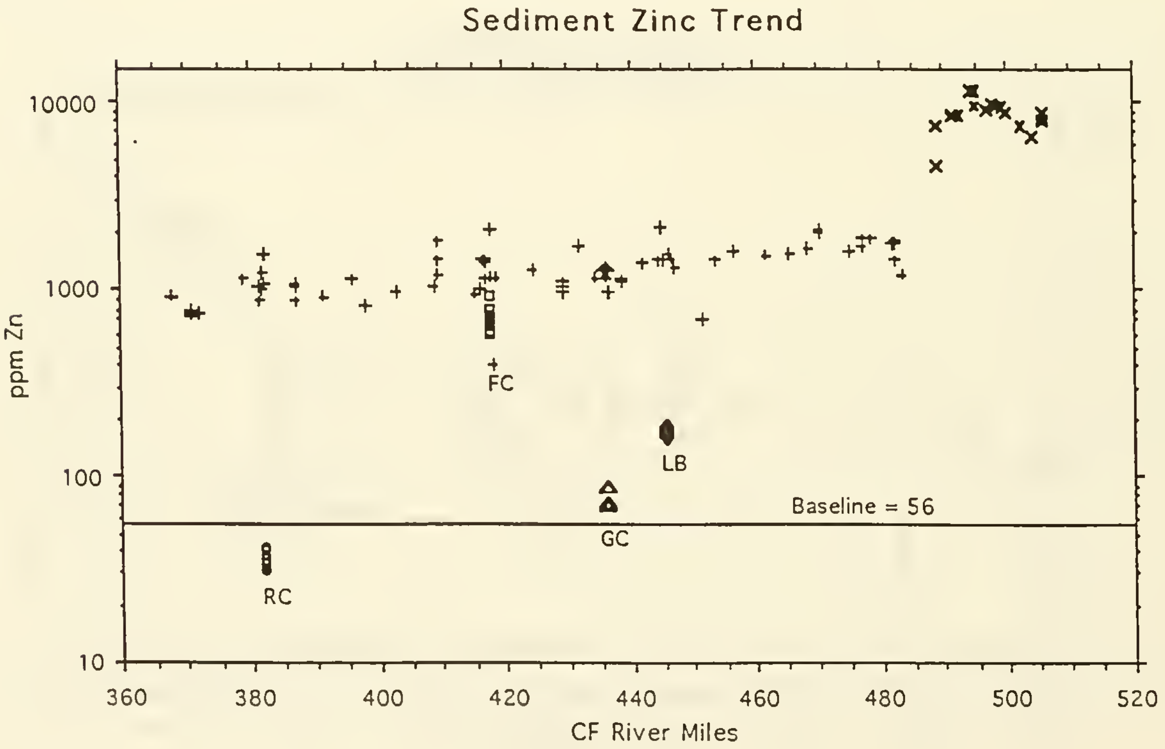
CF
FC
GC
LB
RC
SB
FC
l.o.d. = .3
LB
RC
GC
Baseline = .22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ppm Zn
CF River Miles
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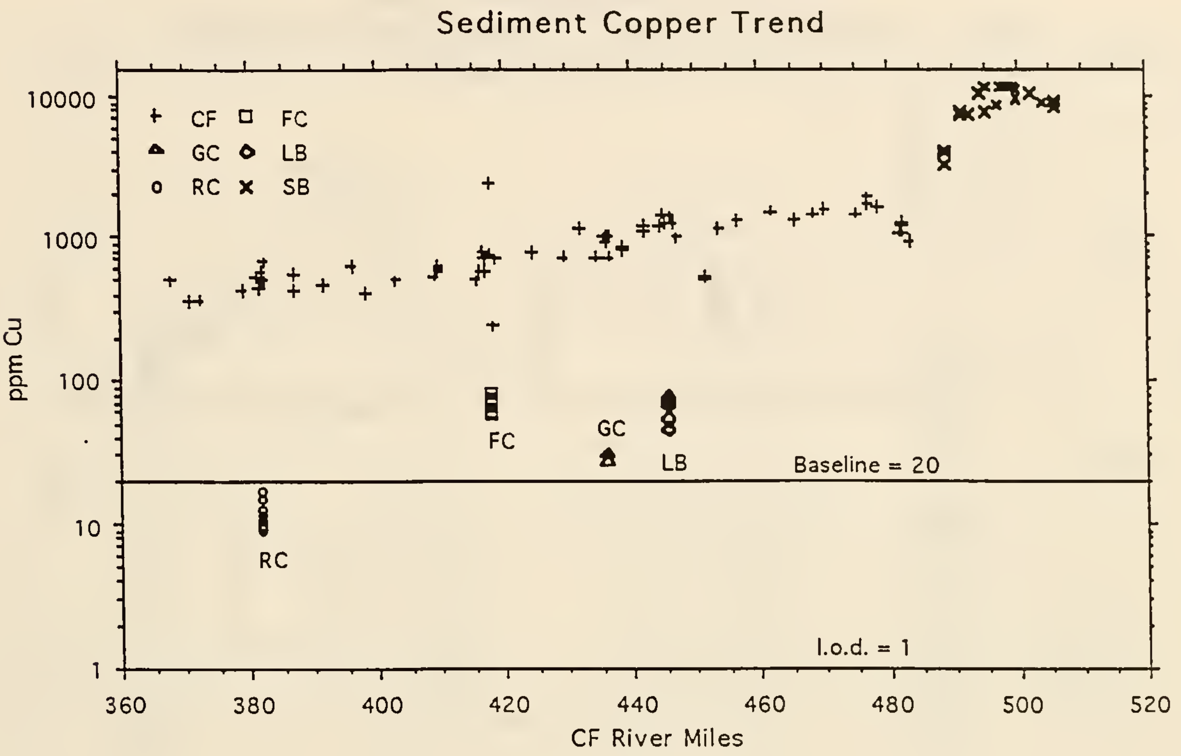
100
10
360
380
400
420
440
460
480
500
520
FC
LB
GC
Baseline = 56
RC

Figure 8


Sediment Copper Trend
+ CF
□ FC
△ GC
◇ LB
o RC
× SB
10000
1000
100
10
1
ppm Cu
FC
GC
LB
RC
Baseline = 20
l.o.d. = 1
360
380
400
420
440
460
480
500
520
CF River Miles

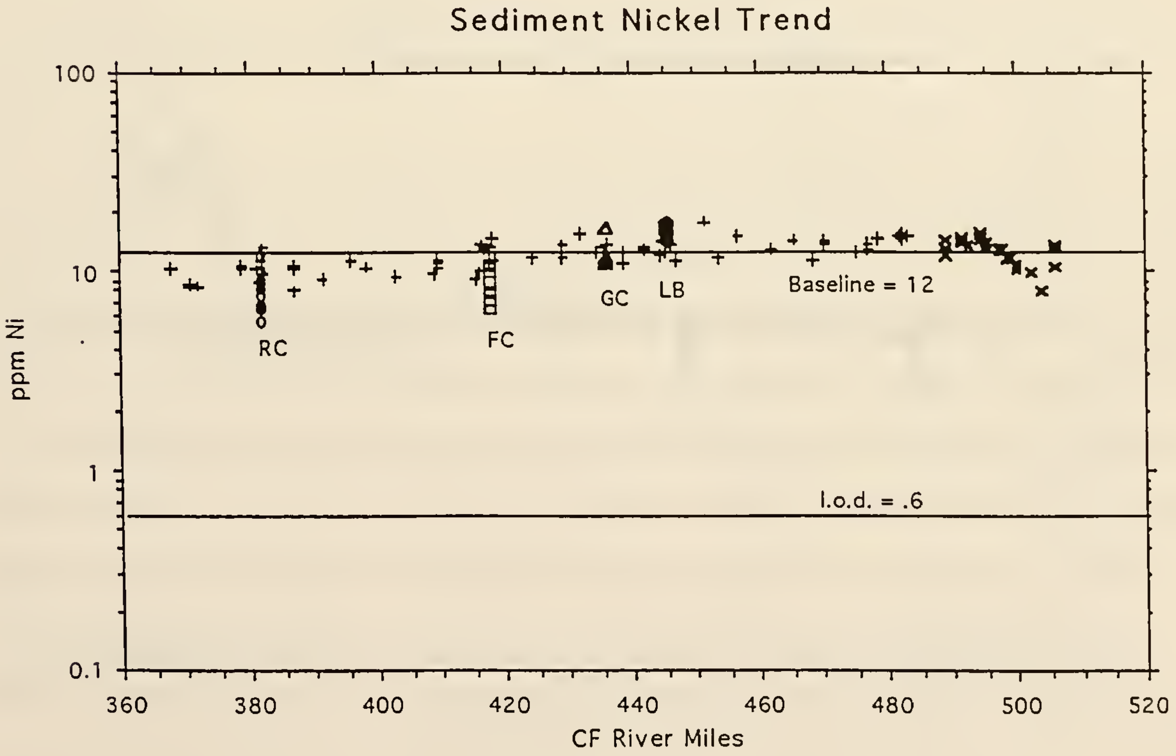
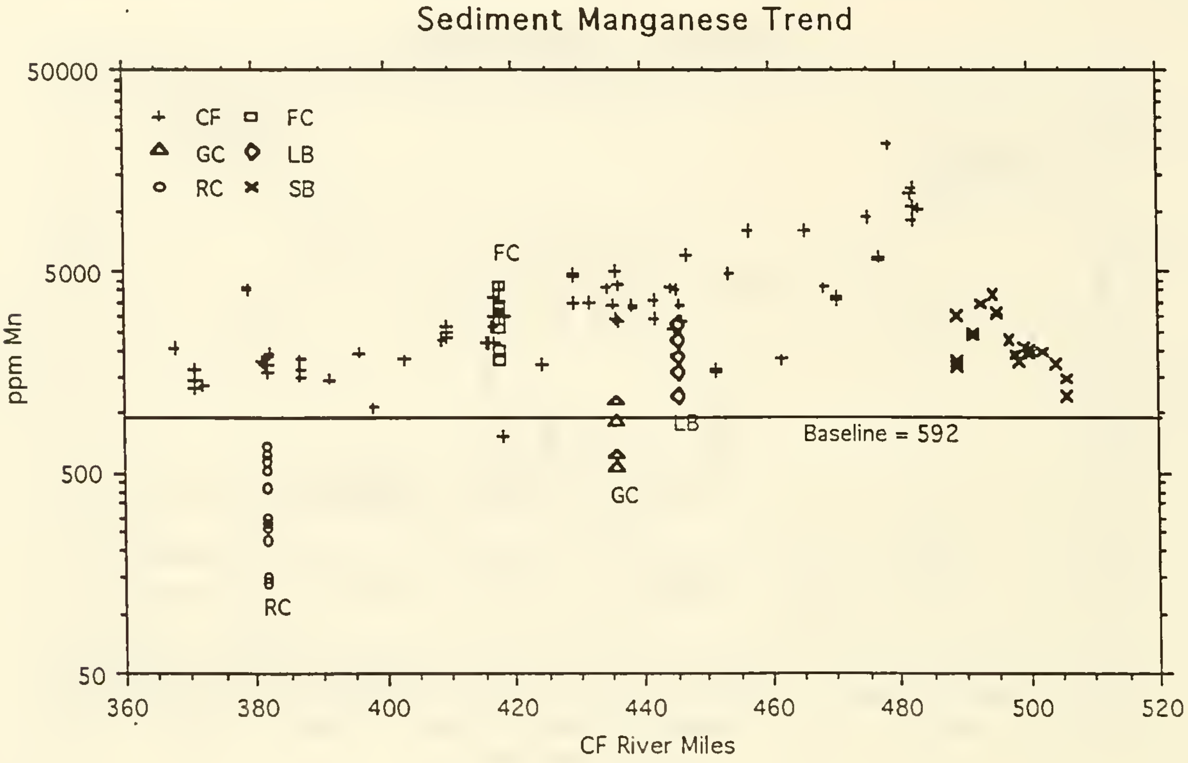

Sediment Nickel Trend
100
10
1
0.1
ppm Ni
RC
FC
GC
LB
Baseline = 12
l.o.d. = .6
360
380
400
420
440
460
480
500
520
CF River Miles

Figure 9


Sediment Manganese Trend
50000
5000
500
50
ppm Mn
CF
FC
GC
LB
RC
SB
FC
LB
GC
RC
Baseline = 592
360
380
400
420
440
460
480
500
520
CF River Miles

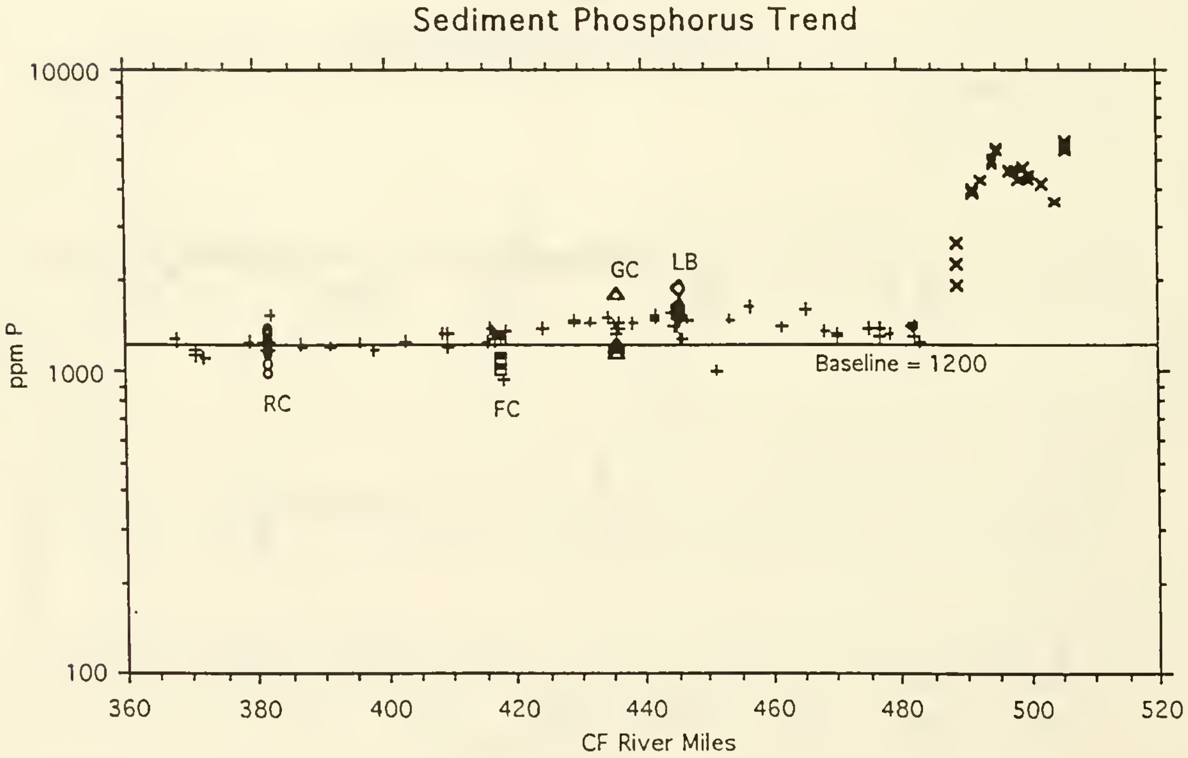

Sediment Phosphorus Trend
10000
1000
100
ppm P
GC
LB
RC
FC
Baseline = 1200
360
380
400
420
440
460
480
500
520
CF River Miles

Figure 10

Table 10
Analyte Concentration Ranges in Clark Fork and Silver Bow Sediment

		Clark Fork River	Silver Bow Creek	Local Baseline
%	Al	0.66 - 1.34	1.05 - 1.47	—
	Ca	1.5 - 11.5	< 1	3.13
	Fe	1.1 - 3.3	2.9 - 4.3	1.36
	Mg	0.41 - 1.06	0.35 - 0.66	0.61
ppm	**As**	22 - 297	230 - 1130	7.0
	Cd	1.3 - 11.1	21 - 45	0.22
	Cu	245 - 2360	3770 - 11600	20
	Mn	755 - 21600	1290 - 3800	590
	Ni	8.4 - 17.8	8.1 - 15.1	11.9
	P	940 - 1650	2300 - 5600	1200
	Pb	46 - 335	537 - 2170	15.4
	Zn	404 - 2140	5510 - 11600	56.5

Contaminant metals appear in **boldface**

The predominant trend in sediment metal concentrations, with a few exceptions noted later, is an increase upstream within the Clark Fork River–Silver Bow Creek—the nearer the sediment sampling site is to Butte the greater is sediment metal concentration. This trend appears to be log–linear for many elements, particularly the contaminants As, Cd, Cu, Pb, and Zn. Log–linear regressions for these five elements in the Clark Fork data and combined Clark Fork–Silver Bow data versus river miles give R-squared values ranging from 0.33 to 0.77 (Table 11), the log–linear trend is stronger (greater R-squared) when Clark Fork and Silver Bow Creek data are combined. Close inspection of the semi–log plots for these elements indicates that the trends are still curvilinear with respect to the log of sediment concentration, with a steepening of slope further upstream. Double log transformations were tried with no improvement in regression results.

A log linear decline would be expected to result from a single upstream source[4] being diluted by clean sediment in a basin whose:

i) drainage area was a simple power function of stream length;
ii) sediment yield per unit area and sediment quality were uniform, and;
iii) in which no net geochemical partitioning of metals occurred (Hawkes,1976; Rose, Dahlberg, and Keith, 1970).

Table 11
Sediment Metals Concentration vs. River Miles (Log Linear Regression R-Squared Summary)

Log	**CF** n=55	**CF/SB** n=68
As	0.61	0.77
Cd	0.42	0.67
Cu	0.61	0.73
Pb	0.44	0.65
Zn	0.33	0.61
Fe	0.53	0.75
Mn	0.57	0.13
Ni	0.53	0.22

Although steepening upstream, the Clark Fork–Silver Bow trend for As, Cd, Cu, Pb, and Zn is remarkably like that which a simple dilution model would predict.

In addition to revealing the general mainstem trend, these plots show how tributary sediments compare to the Clark Fork–Silver Bow sediment concentrations, and reveal interesting differences among metals in these trends. For the major constituents Al, Fe and Mg, the tributary data generally fall on the Clark Fork trend. Clark Fork sediment aluminum (Figure 5) increases linearly upstream, Rock Creek, Flint Creek, and Little Blackfoot River sediment aluminum lie on this trend, Gold Creek is somewhat above the trend. The upstream aluminum increase continues unbroken into Silver Bow Creek. Warm Springs ponds have no apparent affect on sediment aluminum concentrations.

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[4] A single source can be an area, quite large in extent, which effectively contributes to a drainage at one point, for example a tributary basin.

The Clark Fork sediment iron (Figure 5) trend is concave, increasing at a faster rate upstream, however, all four tributaries fall right on the trend. Concentrations continue to rise in Silver Bow Creek with a distinct increase in slope occurring at Warm Springs ponds. This suggests a change in iron geochemistry from Silver Bow Creek to the Clark Fork River, likely the result of an increase in pH due to liming in the ponds causing decreased iron mobility in the Clark Fork. Manganese (Figure 10), although geochemically similar to iron in that it forms coatings on bed sediment particles, has a very different trend. Sediment manganese is lower in Silver Bow Creek than in the Clark Fork just below the ponds. The downstream decrease is more gentle than for iron and appears linear, and the data are much more variable than is the case for any other element measured. The Warm Springs ponds appear to be acting as a source for manganese in the Clark Fork River.

Sediment calcium and magnesium are unlike all other elements, but like manganese, in that they are lower in Silver Bow Creek than in the Clark Fork and show a spike in concentration just below the ponds. This spike is almost certainly the effect of lime added to the Warm Springs ponds. Magnesium in tributary sediments correspond to mainstem Clark Fork levels, while calcium in the tributaries is below mainstem concentrations. The sediment calcium trend is unusual in that it decreases downstream until just west (downstream) of Flint Creek, where limestones are encountered along the river, and then increases downstream to levels near those found just below the ponds. This illustrates both the strong control of changes in basin geology and upstream anthropogenic inputs on calcium abundance.

Arsenic and lead in the tributaries share relationships to the mainstem which are almost identical (Figure 7). Flint Creek sediments are higher in both As and Pb than Clark Fork sediments at their confluence, and are similar to uppermost Clark Fork sediments. The Little Blackfoot River, Gold Creek, and Rock Creek are all lower than the Clark Fork River at their confluence with the Clark Fork. Gold Creek and Rock Creek are at or near the baseline for both As and Pb, lower than any site sampled in the Clark Fork. Clark Fork sediment arsenic remains elevated 5-7 times above baseline at the downstream end of the trend, just above Milltown Reservoir—the point of least contamination—while lead is elevated 5-6 times above baseline. Although Flint Creek sediments are enriched in As and Pb to levels higher than the Clark Fork River at the confluence, their input does not noticeably alter the downstream decrease in concentrations of these two contaminants in Clark Fork sediments below Flint Creek. This is strong evidence that Flint Creek is not a significant source of As and Pb, any contribution that Flint Creek makes is being overwhelmed by the magnitude of contamination emanating from upstream in the Clark Fork River.

Cadmium and zinc (Figure 8) also display very similar Clark Fork trends, and relationship of tributary to mainstem sediment concentrations. Flint Creek is elevated about ten-fold above baseline for both of these contaminants but it is still below the Clark Fork–Silver Bow trend. All other tributaries are near (within a factor of 3) or below baseline for cadmium and zinc, well below the Clark Fork–Silver Bow trend. Although elevated, Flint Creek sediments are lower in cadmium and zinc concentration than the Clark Fork sediments just above Milltown Reservoir where concentrations of both are more than fifteen–

fold above baseline. Both Cadmium and zinc increase upstream in the Clark Fork River to more than 150-fold enrichment in Silver Bow Creek.

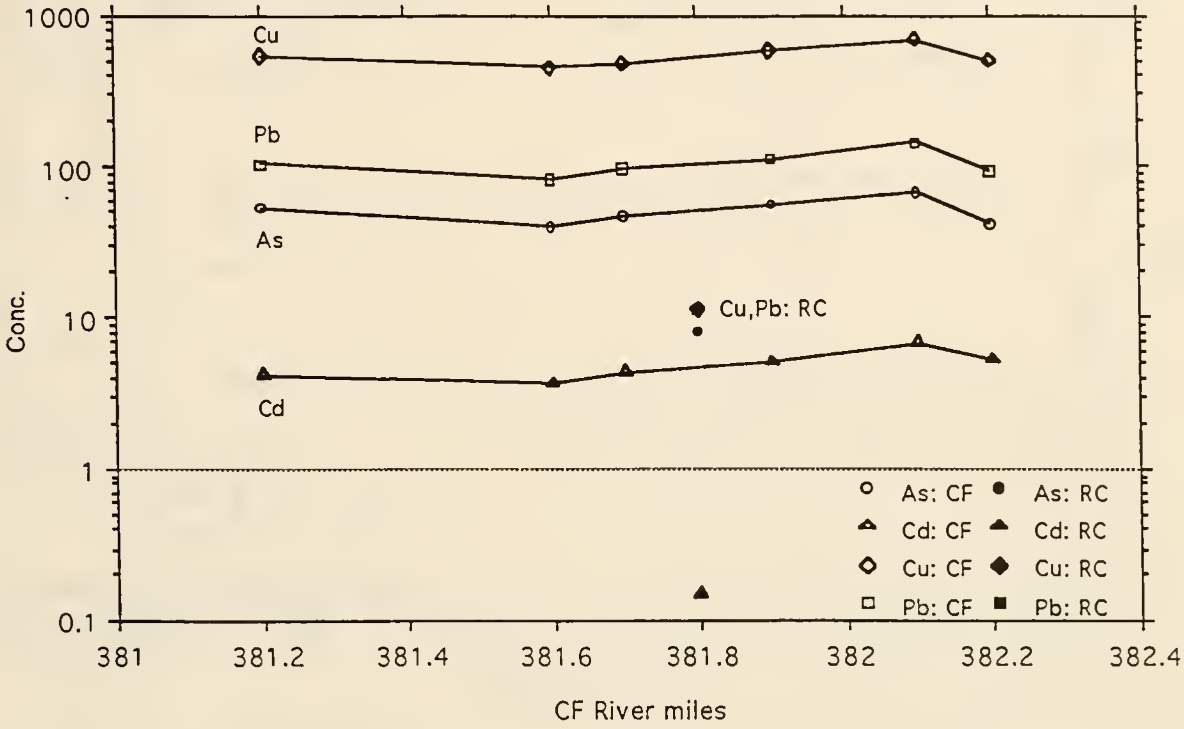
Copper is unique among the five contaminants (As, Cd, Cu, Pb, & Zn) in that all four of the tributaries sampled in this study, including Flint Creek, have sediment concentrations for copper well below the Clark Fork–Silver Bow trend (Figure 9). If Flint Creek were a major source of sediment load to the Clark Fork, with such a distinct difference in sediment copper concentrations we would expect to see a drop in Clark Fork sediment copper below the Flint Creek confluence. There is no evidence of such a drop in concentration. Therefore, Flint Creek is not a major source of sediment and hence can not be a major source of copper or other contaminants whose concentrations in Flint Creek are lower (Cd, Cu, Zn) than in the Clark Fork. Clark Fork sediment copper displays a rise similar to cadmium and zinc, but more pronounced, sediment copper concentrations rise from around twenty-fold enrichment above Milltown reservoir to greater than 400-fold enrichment in Silver Bow Creek.

Nickel is very different from all of the principal contaminants As, Cd, Cu, Pb, and Zn, in that its trend in the Clark Fork River–Silver Bow Creek is very slight and approximates baseline concentrations on average (Figure 9); all values from the tributaries fall on the mainstem trend. This behavior is expected for a "conservative" element whose concentrations are not augmented by anthropogenic input and whose release to the environment is controlled primarily by natural weathering. The slight downstream decrease that is observed could be the result of a progressively more mature (weathered) landscape as one moves downstream in an area of uniform average bedrock nickel content, a slowly decreasing nickel content (on average) in bedrock downstream, or a residual grain size trend in fine bed sediments. The "conservative" behavior of nickel makes it useful for constructing enrichment ratios.

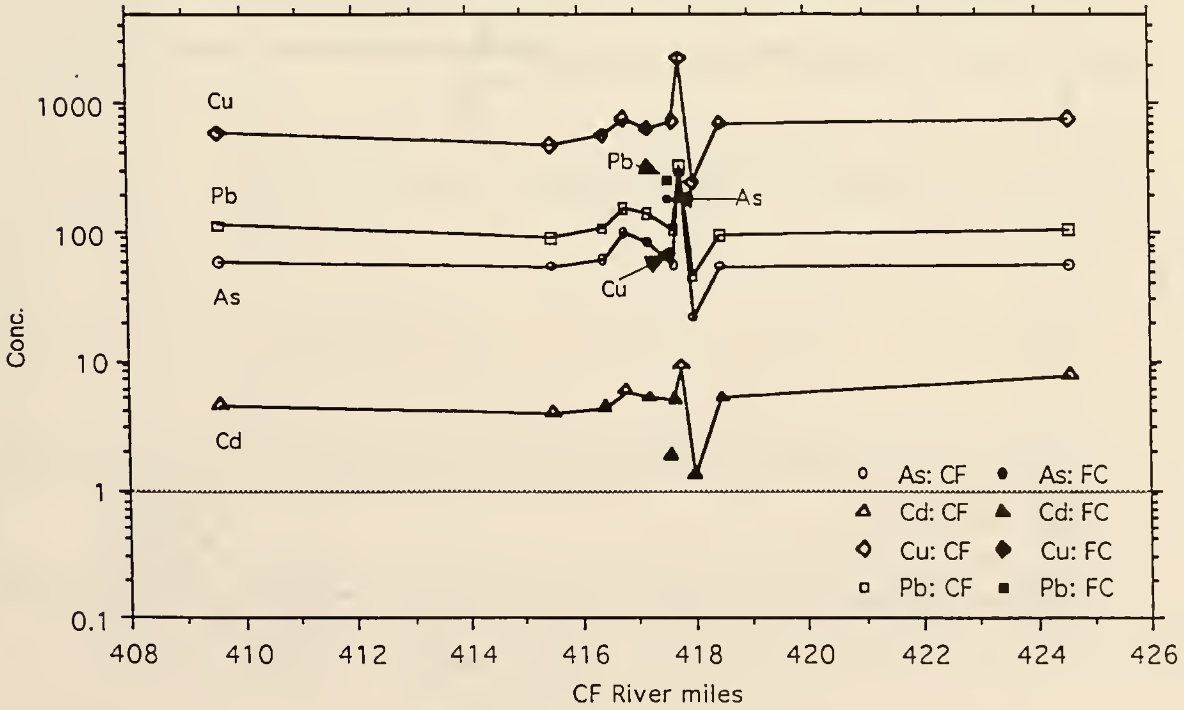
Close-up of Trends at Tributaries

One question regarding Clark Fork sediment contamination is the role tributaries. A better appreciation of tributary contribution to (or dilution of) Clark Fork sediment contaminants is gained by inspection of graphs of the trends in the vicinity of each confluence (Figures 11-12). Each of these graphs combines data for As, Cd, Pb, and Cu, at a tributary. Zinc is plotted on separate graphs (Figures 11a-12a) because the data coincide almost exactly with those for copper; plotting both on the same graph would make it difficult to discern the two. Average values for the tributary are plotted as separate solid points, and values for the three sampling sites up and downstream of the confluence in the Clark Fork are plotted as open points connected by a line; upstream is to the right. In figures 11 and 11a, the graph for Flint Creek extends the view to five sites on either side of the confluence, because of variable data in the immediate vicinity of the Flint Creek confluence.

The salient feature of all four figures is that sediment concentrations of these five metals (As, Cd, Cu, Pb, and Zn) vary in concert. Where one rises the others rise also, and to about the same degree. The minor fluctuations in the trend reflect within site variability, probably due to such factors as differences in total organic carbon, residual particle size distribution, and incomplete mixing of upstream sediment with locally derived cleaner sediment. The strong covariation in metals means that metal ratios are nearly constant despite within– and between– site variability. These constant ratios, in turn, reflect the overwhelming control of Silver Bow Creek sediments on downstream metal concentration.The dominance of physical dilution rather than geochemical or biological partitioning attenuates sediment metals downstream away from the source of contamination The lack of importance of the latter factors is probably due not so much to their absence as to the immense



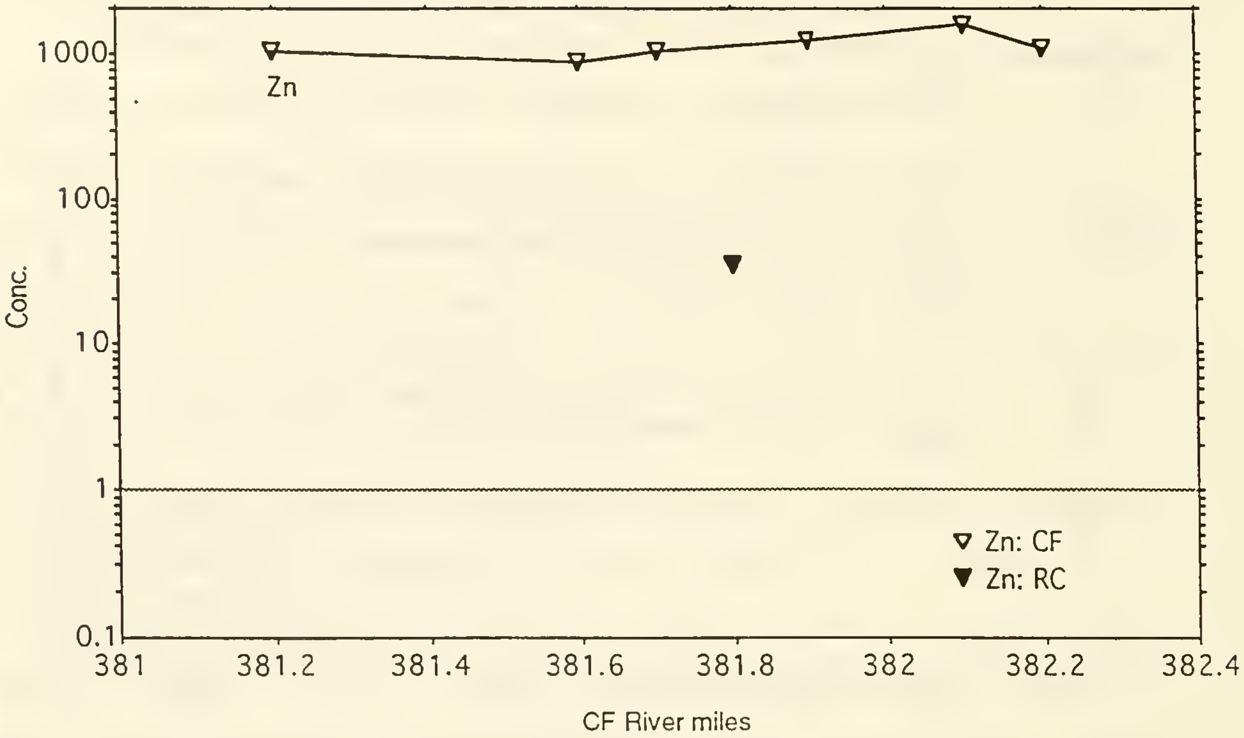
Sediment Metal Concentrations Near Rock Creek



Sediment Metal Concentrations Near Flint Creek

Figure 11

Sediment Zinc Concentrations Near Rock Creek



Sediment Zinc Concentrations Near Flint Creek

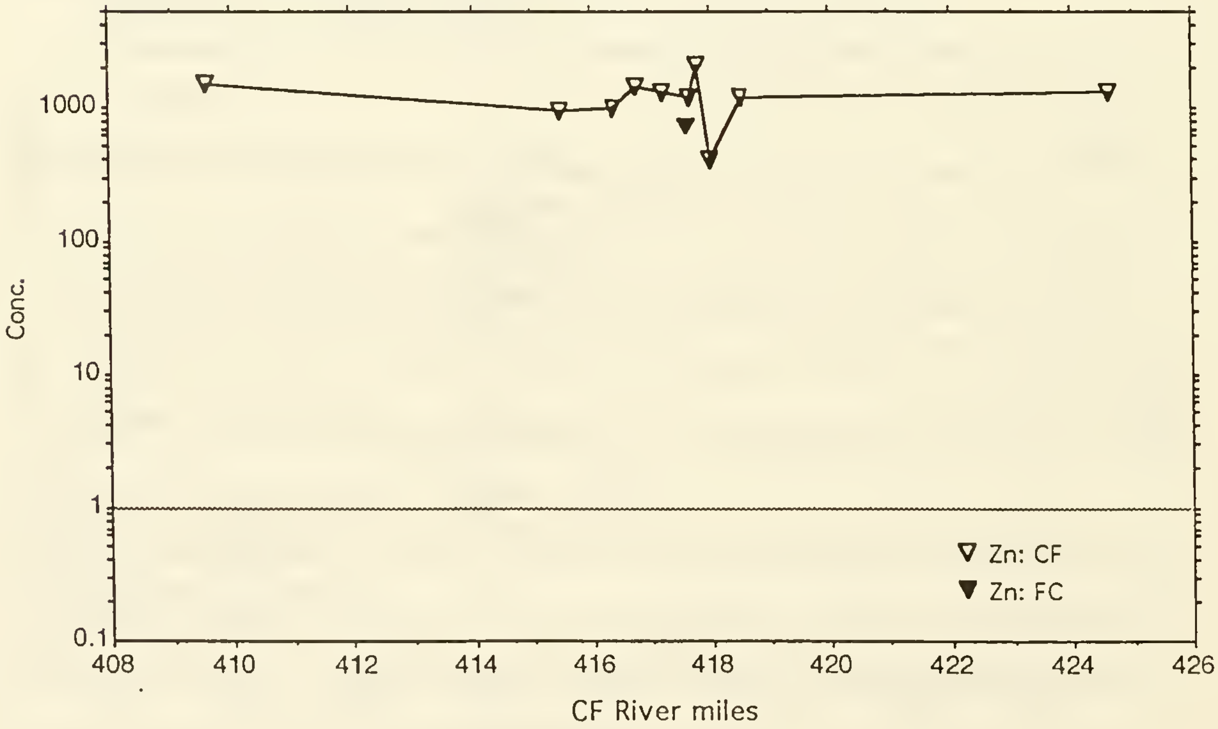
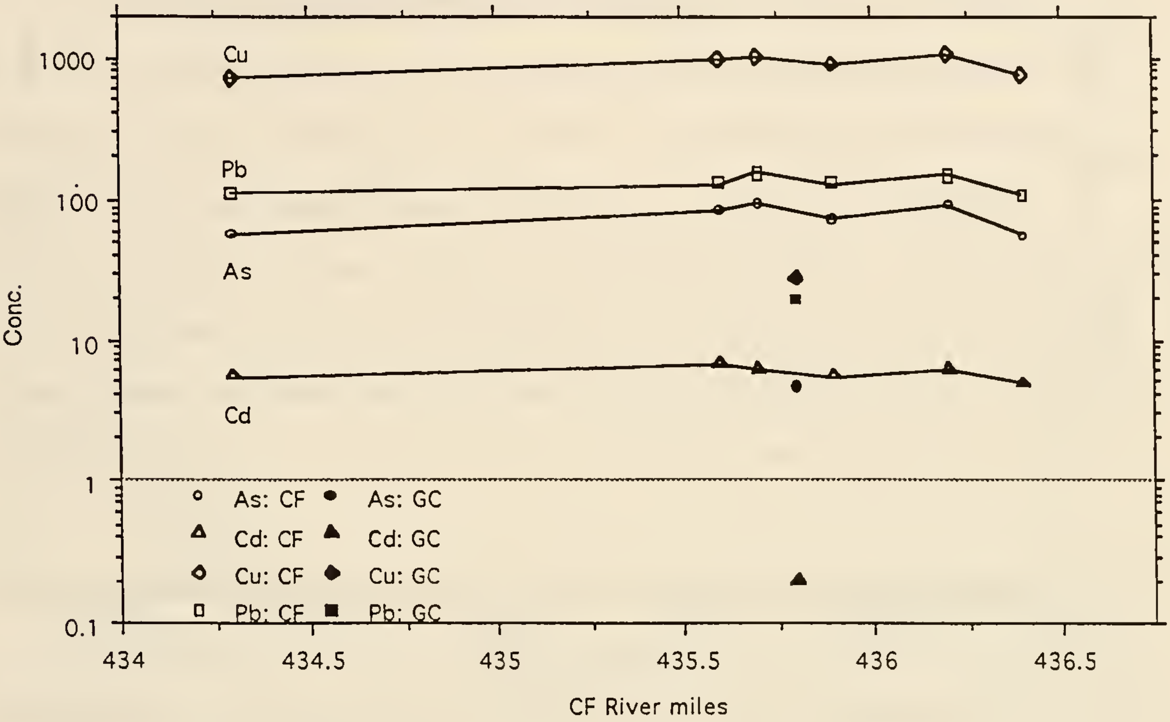


Figure 11a

Sediment Metal Concentrations Near Gold Creek



Sediment Metal Concentrations Near Little Blackfoot River

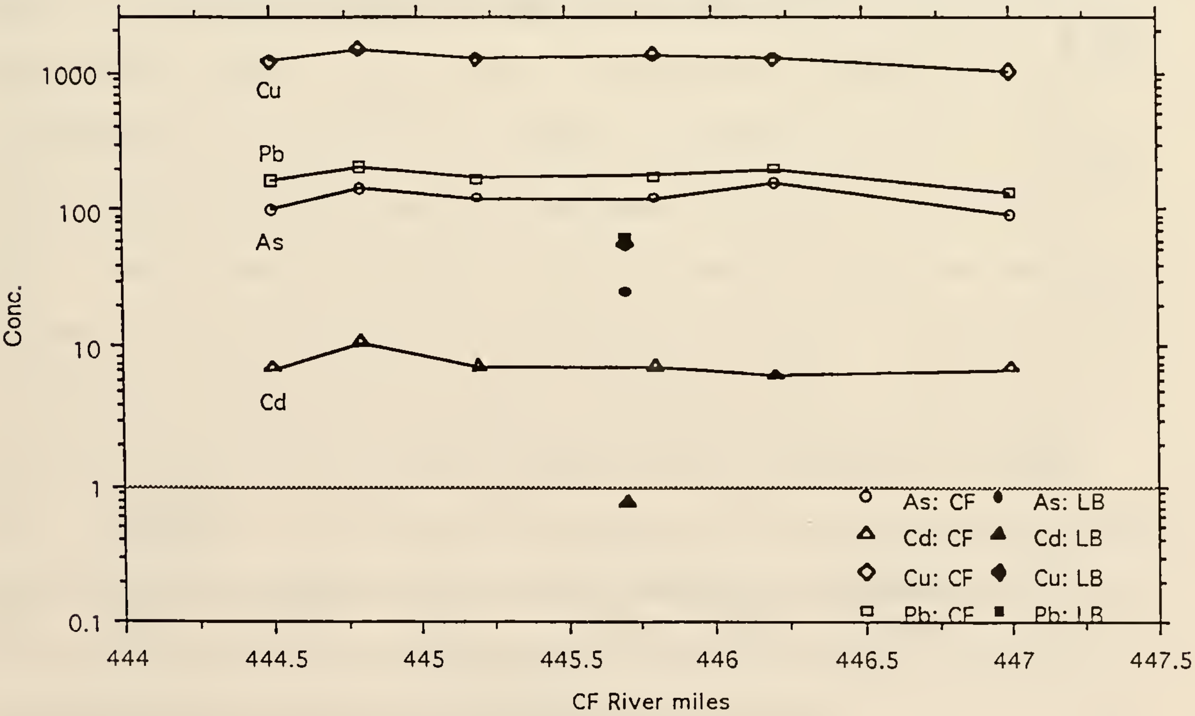
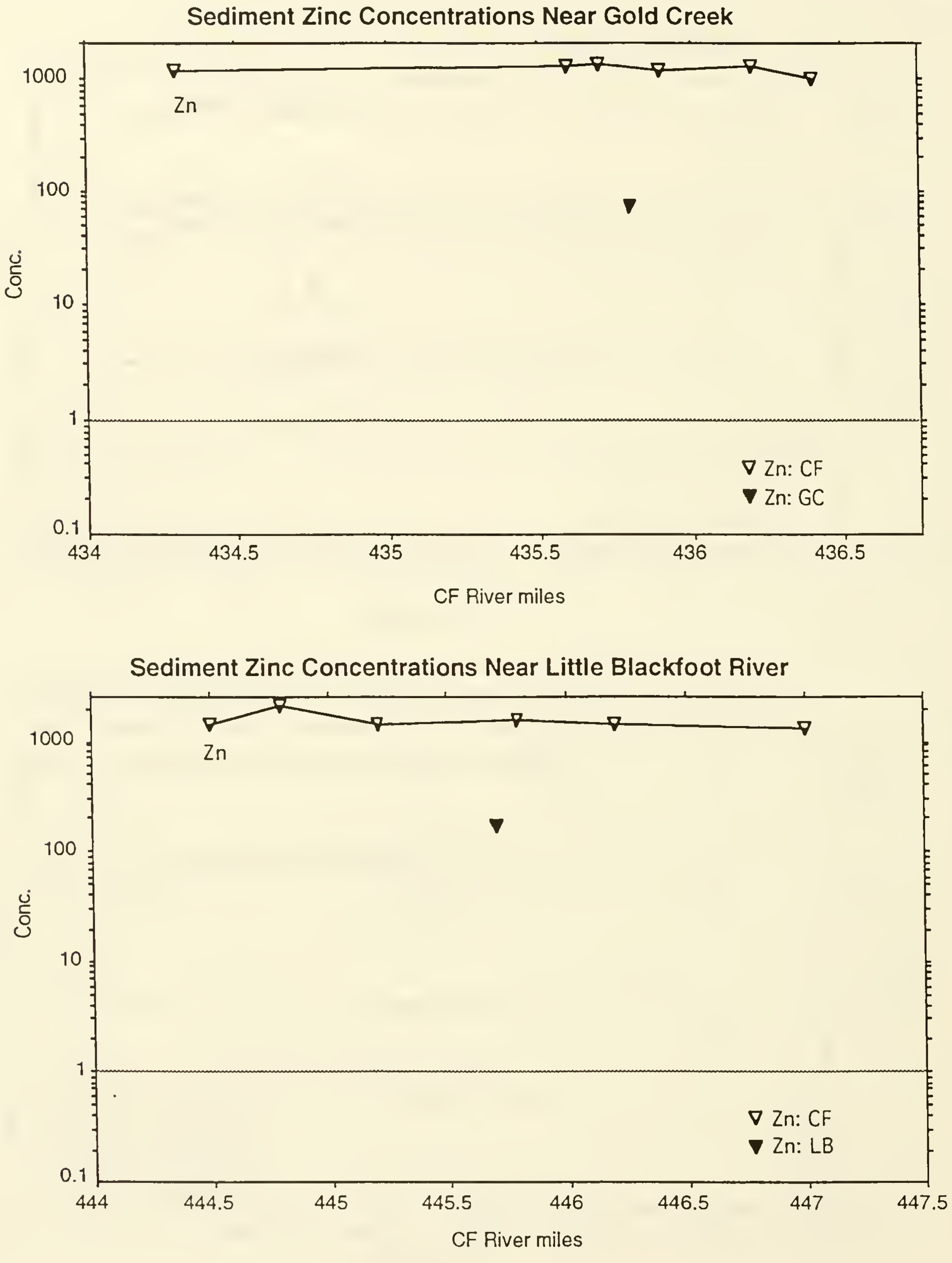


Figure 12


Sediment Zinc Concentrations Near Gold Creek

Sediment Zinc Concentrations Near Little Blackfoot River

Figure 12a

loading of system with contaminants.

Nearly as striking is the lack of disturbance of the overall Clark Fork river trend by these tributaries, only Flint Creek shows any effect, and that is only short range, extending little more than two miles downstream, but this does not affect the larger Clark Fork trend, a conclusion also reached by Axtmann, Cain and Luoma (1990) based on 1989 sediment chemistry. Clearly, the sediment chemistry of Clark Fork River sediments is dominated by transport from upstream, and the tributaries have little impact on bed sediment chemistry in the mainstem.

"Fingerprinting" Sources of Contamination Using Elemental Ratios

Geochemists have long employed elemental ratios to study rock types, crustal evolution, and mixing of sources (Ahrens, 1965; Wedepohl, 1967; Taylor and McLennan; Faure, 1991), as well as metals enrichment (Bowen, 1979; Förstner and Wittmann, 1981; Salomon and Förstner, 1984) or contamination (Windom et al., 1989; Loring, 1990). Ratios factor out the effect of varying concentrations that may be caused by grain–size effects or sediment dilution, and allow the examination and characterization of sediments from different areas. Even without knowledge of source chemistry or budgets, we can take advantage of differing metal ratios to distinguish sediments, "fingerprint" their sources, and calculate mixing ratios for component sources. A similar ratio between sediments from different streams implies that they have a similar source chemistry—assuming that similar geochemical processes operate in both streams. Ratios that remain the same with changing contaminant levels within a stream indicates that only non-selective geochemical processes, and/or physical processes (such as dilution) have affected the sediments.

Plotting data for two metals on the same graph not only displays information on their respective concentrations, but also their ratio. If, in addition, the data for each stream are given unique symbols, any clustering of points resulting from distinction between streams becomes evident. Log-log plots are utilized because they can encompasses a large variation in elemental concentrations; low values plot in the lower left corner and the greatest contamination in the upper right. A line of equal concentration for the two variates (a ratio of 1:1, or unity) will rise from left to right and connect the opposite corners of successive log cycle rectangles[5]. Any diagonal line rising from left to right which parallels that line of equal concentration is a line of constant elemental ratio. If we define the ratio to be X/Y, then any line below the equal concentration line has a ratio greater than one, and a line above is less than one.

A line of constant ratio implies that both elements in the ratio are being geochemically or physically partitioned to the same degree. Sediments physically diluted in a given geochemical environment, or ones experiencing geochemical partitioning of elements to the same degree, will maintain a constant ratio (the ratio of their source) as elemental concentrations fall or rise. The Clark Fork River sediments show just such behavior, with data falling around a line pointing to Silver Bow Creek (Figures 13 & 14). In these and subsequent figures of this kind we also show a shaded "Baseline Box" which identifies data points at or below baseline for both elements depicted.

Any line which diverges from a diagonal (is not parallel to the equal concentration line) represents a changing elemental ratio. Remembering that the ratio is defined as X/Y, lines with slope less than a diagonal describe a ratio that is increasing to the right and therefore decreasing to the left. Conversely, lines with a slope greater than the diagonal describe a ratio decreasing to the right and therefore increasing to the left.

---

[5] If the graph is drawn such that one log cycle has the same dimension for both axes, the rectangles will be squares and the diagonals will be at an angle of 45 degrees.

If the two elements making up a ratio are differentially partitioned, either geochemically or by mixing with tributary sediment of a different ratio, then the elemental ratio in the resulting sediment will diverge from the ratio of the upstream source. But even under such conditions of partitioning the trend in ratio will point to or converge with the source ratio as sediments are taken closer to the source. This situation is exemplified in the Clark Fork River by figures 15 and 16.

Although many of the streams we studied have elevated metals concentrations in their sediments, these metals occur in different proportions from stream to stream. The proportions in any given stream depend on the types and extent of sources and geochemical processes which selectively partition elements. No single metal-metal ratio can be expected to uniquely distinguish as many streams as examined in this study. However, a combination of ratios can serve to separate streams because of differences in bedrock geology controlling sediment baseline, and the nature and extent of mining/smelting wastes controlling contamination. Where mining has contaminated a stream in the absence of other factors, we expect the fingerprint of this contamination to control metals ratios in downstream sediments.

Boxplots of data by stream (Figures 1-4) show that copper figures prominently in the contamination of Clark Fork River and Silver Bow Creek sediments. Therefore, we look mainly at log-log plots involving copper to distinguish sources of contamination. Each of the log-log metal plots presented (Figures 13-19) is accompanied by a companion figure of that metal ratio versus river miles in the Clark Fork Basin (Figures 13a-19a). These companion graphs make it easier to see the effect, or lack thereof, of tributaries on the

Clark Fork metal ratios.

The log-log plot of copper versus lead (Figure 13) shows the commonality of Clark Fork and Silver Bow Creek sediments and clearly distinguishes these two streams from the other streams studied. The Clark Fork data align neatly along a diagonal, strong evidence of simple dilution from an upstream source. Silver Bow Creek sediments, although more variable, possess about the same Cu/Pb ratio as the Clark Fork sediment, and are unlike any other stream studied in the basin or without. This fingerprints Silver Bow Creek as the proximate source of contamination in the Clark Fork River. Copper/lead ratios for Flint Creek cluster apart from the Clark Fork–Silver Bow ratio; signatures which clearly separate the two streams. Copper versus arsenic (Figure 14) presents essentially the same picture, except that the Cu/As ratio decreases stepwise across the boundary between Silver Bow Creek and Clark Fork River sediments. This change results from a larger decrease in Cu concentration versus As concentration through the Warm Springs ponds (Figures 7 & 9) , indicating that the ponds are more effective at retaining Cu than As.

Flint Creek Cu/As ratios cluster away from the Clark Fork–Silver Bow trend in a similar position to the Cu/Pb cluster. These two ratios clearly establish different elemental signatures for Flint Creek and for Clark Fork River–Silver Bow Creek. This strongly supports the assertion that the contaminants Cu, As, and Pb—especially Cu—originate in the headwaters of the Clark Fork River and are subsequently diluted by cleaner sediment as they are transported downstream.

Copper versus iron (Figure 15) is an example of a plot where one element behaves differently than the other. Iron decreases less rapidly than copper, so that the Cu/Fe ratio decreases as the sediment content of these two elements decreases downstream. However, Clark Fork–Silver Bow data still lie on a

Scattergram of Copper vs Lead

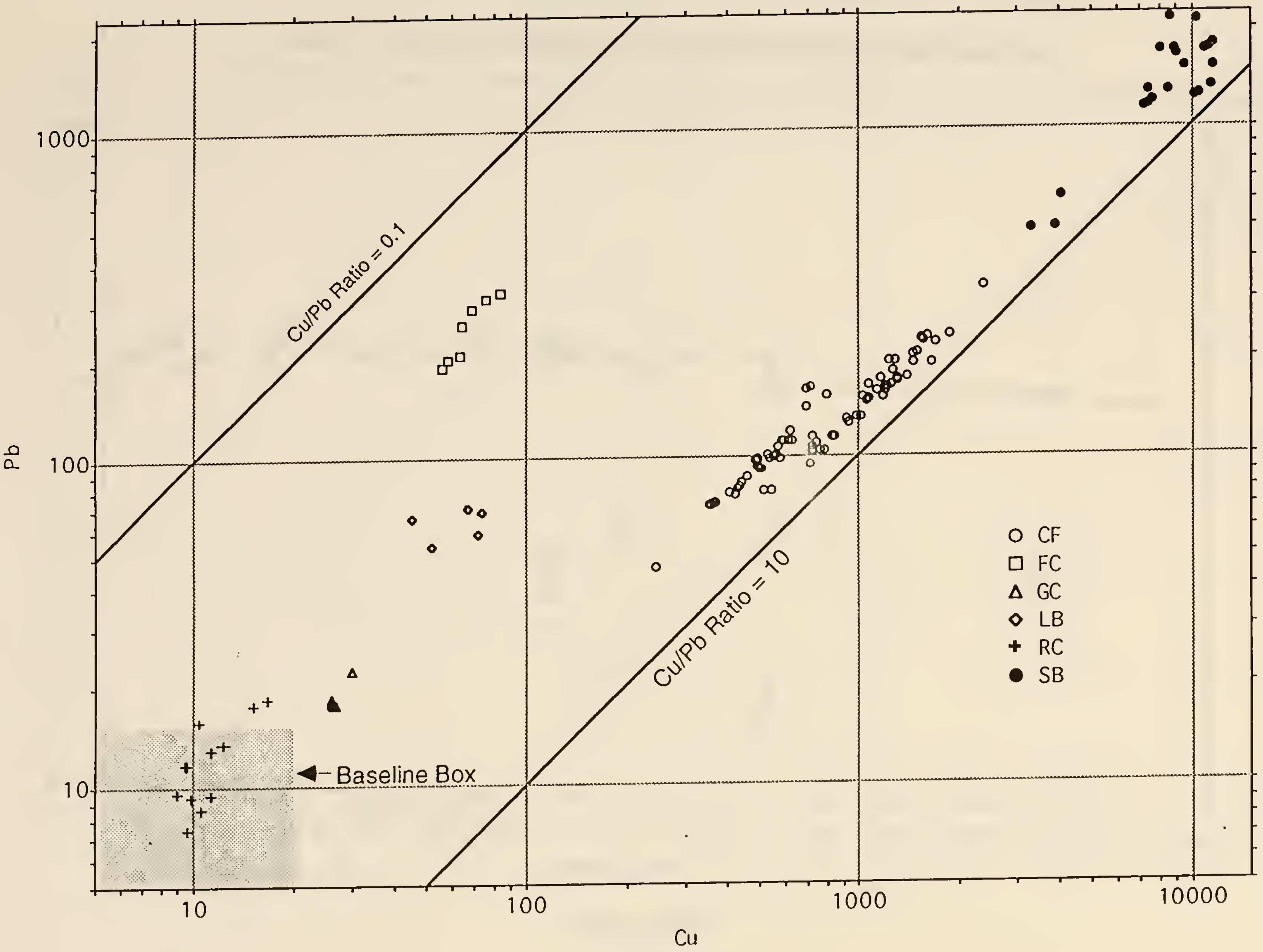
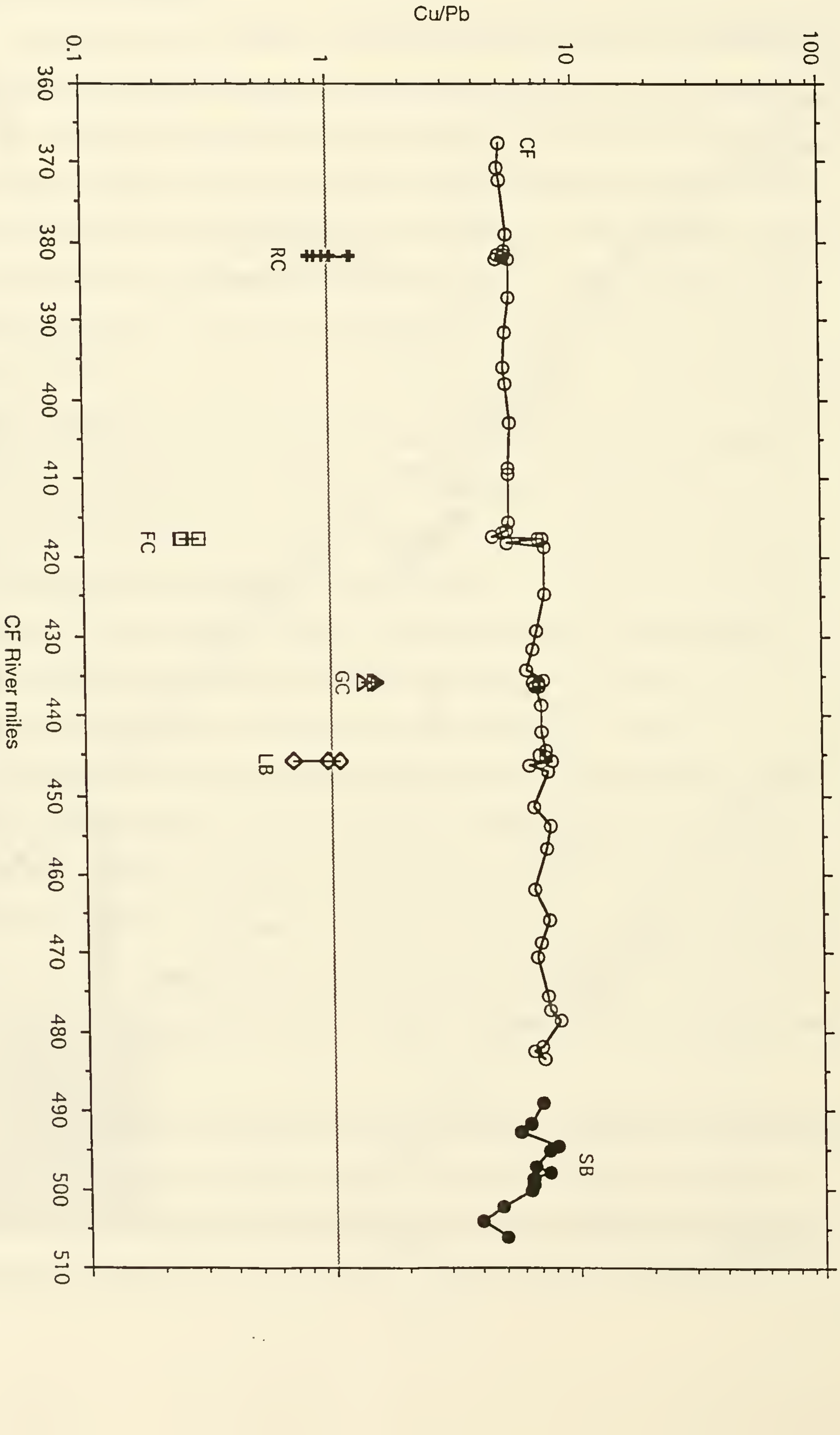
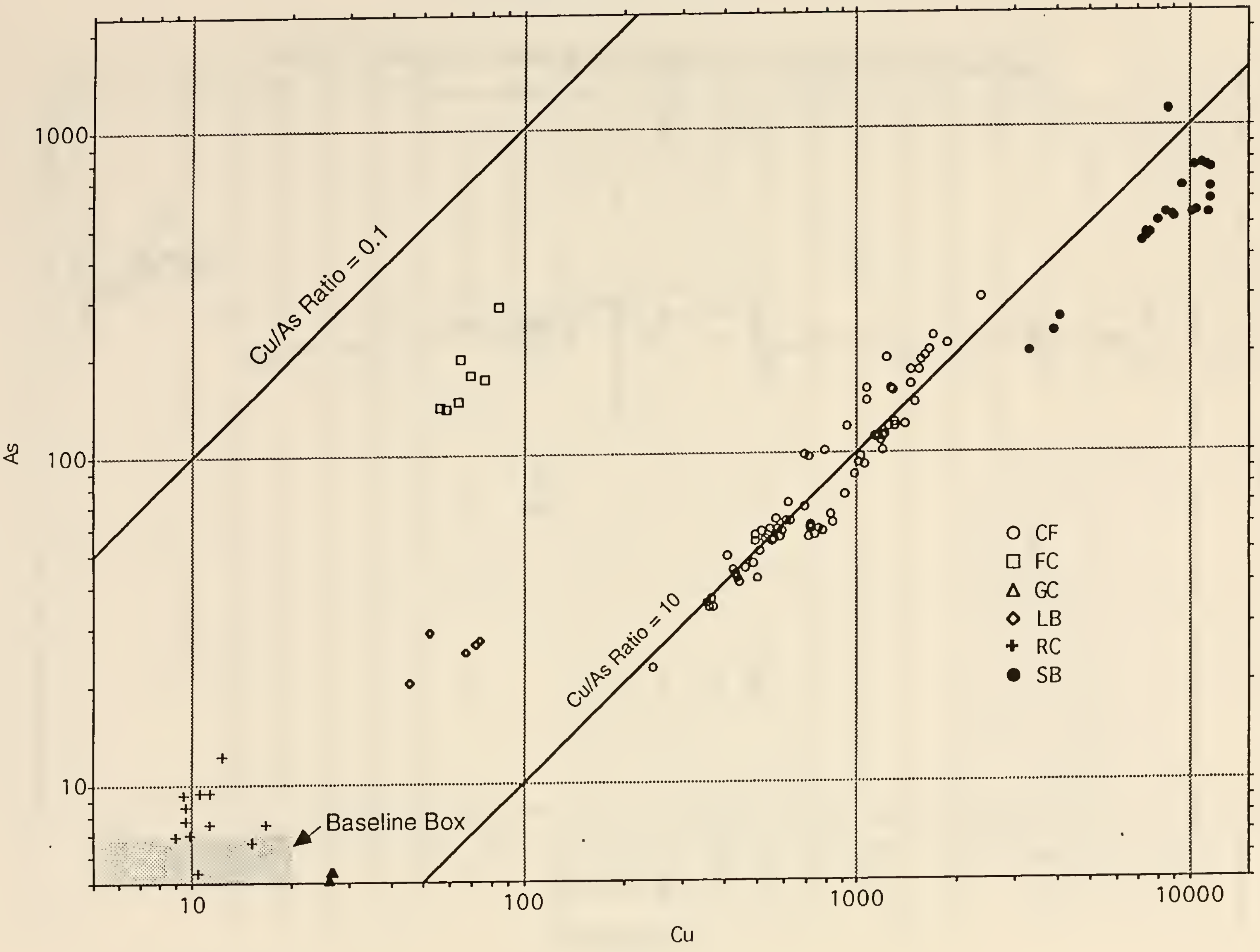


Figure 13



Sediment Cu/Pb Weight Ratio versus River Miles in Clark Fork Basin

Figure 13a



Scattergram of Copper vs Arsenic

Figure 14

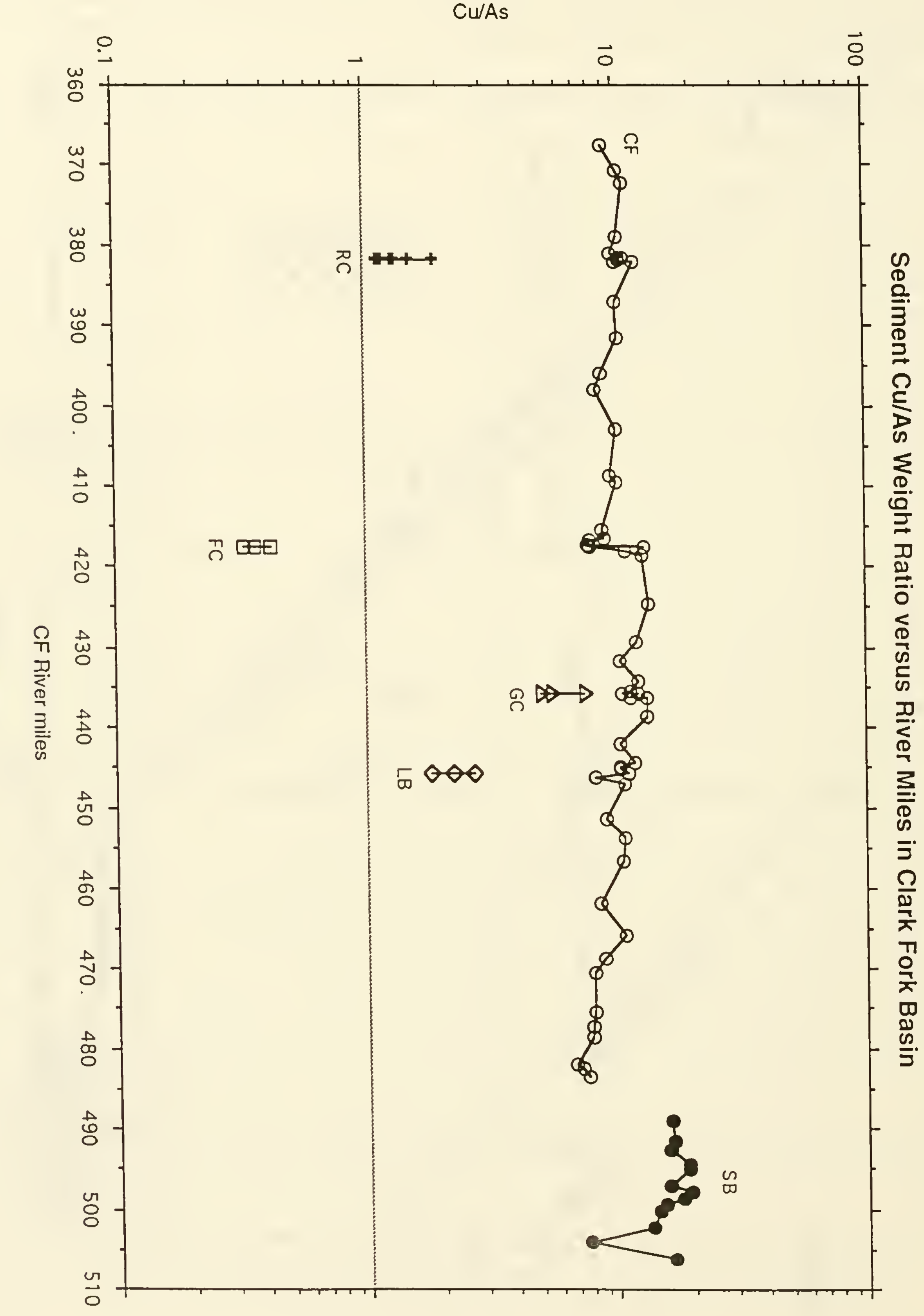

Sediment Cu/As Weight Ratio versus River Miles in Clark Fork Basin
Cu/As
100
10
1
0.1
360
370
380
390
400
410
420
430
440
450
460
470
480
490
500
510
CF River miles
CF
RC
FC
GC
LB
SB

Figure 14a

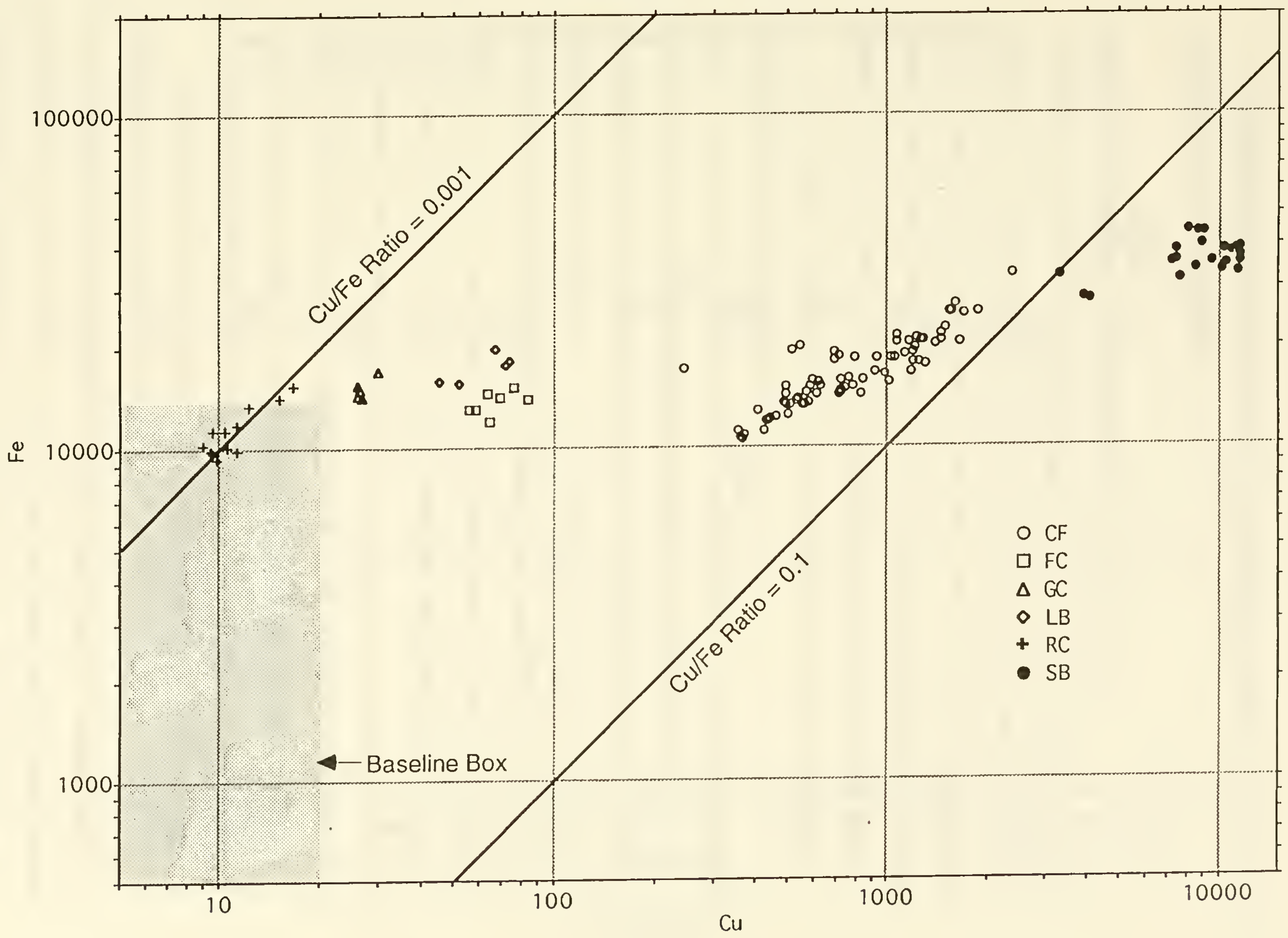
common trend—one separate from the downstream tributaries—so that the distinction between the Clark Fork–Silver Bow sediments and all other streams is clearly evident. This again points to Silver Bow Creek as a major source of contamination in the Clark Fork River.

Copper versus nickel (Figure 16), illustrates a rapidly declining ratio in the Clark Fork–Silver Bow data, this is due to the downstream dilution of sediment copper from a source upstream, compared with the nearly constant baseline nickel in the Clark Fork basin. Again, Flint Creek and the other tributaries separate into clusters distinct from the Clark Fork–Silver Bow trend. Lead versus arsenic (Figure 17), shows a fairly uniform ratio throughout the Clark Fork basin sediments, indicative of a consistent mineralogical source for these two elements. The data also clearly separate into clusters of sediments affected by hard-rock mining (CF, FC, LB, & SB) and those not affected (GC & RC). This implies that, even though concentrations among these streams vary over almost 3-orders of magnitude, basin mineralogy, mining activity, and downstream dilution couple to control metal trends and ratios, which we can utilize as distinguishing characteristics.

Zinc versus cadmium (Figure 18) also displays a uniform Clark Fork Basin ratio. In contrast, the Cu/Zn ratio (Figure 19) slowly decreases downstream (divergence from diagonal as you move left in the figure); Flint Creek however stands alone with a copper zinc ratio which sits well above the trend formed by the remaining data. This has only a minor effect on the Clark Fork sediment Cu/Zn ratio, again demonstrating the trivial input of Flint Creek contamination compared to upstream sources in the Clark Fork.

Metal Enrichment Factors

Sediment metals enrichment can be quantified in at least two ways. The



Scattergram of Copper vs Iron

Figure 15

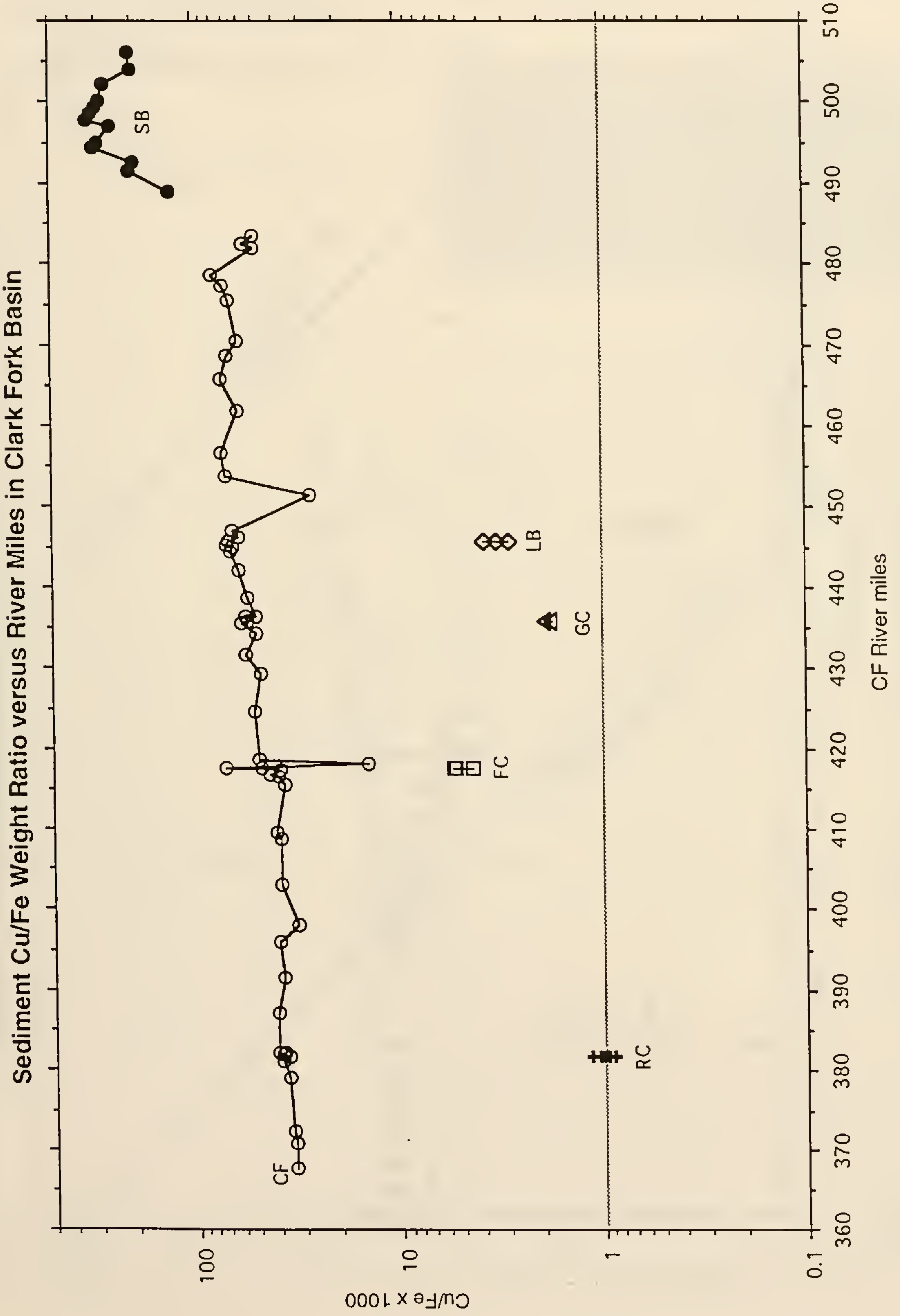

Sediment Cu/Fe Weight Ratio versus River Miles in Clark Fork Basin
Cu/Fe x 1000
0.1
1
10
100
CF River miles
360
370
380
390
400
410
420
430
440
450
460
470
480
490
500
510
CF
RC
FC
GC
LB
SB

Figure 15a

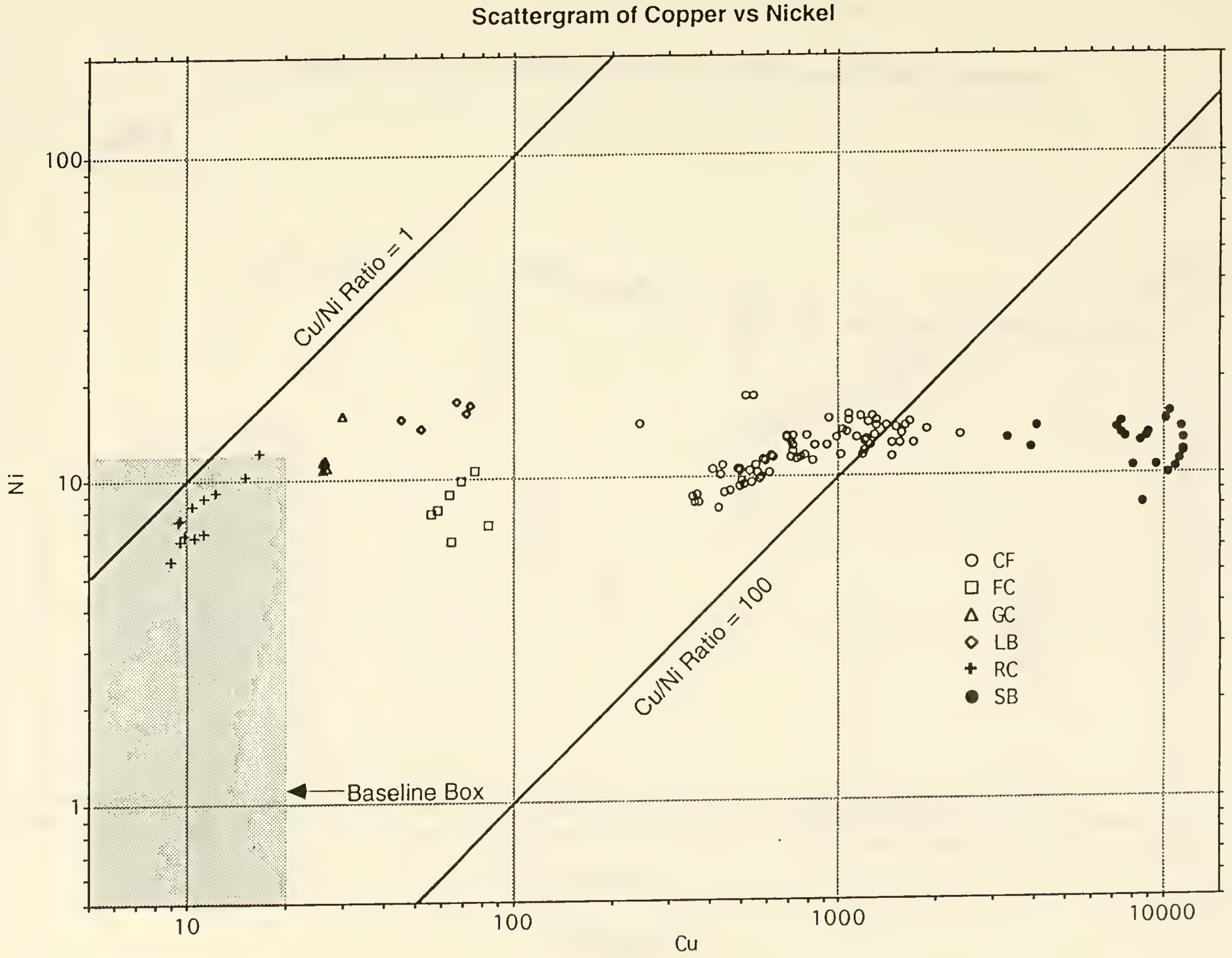

Scattergram of Copper vs Nickel
Ni
100
10
1
Cu
10
100
1000
10000
Cu/Ni Ratio = 1
Cu/Ni Ratio = 100
Baseline Box
○ CF
□ FC
△ GC
◇ LB
+ RC
● SB

Figure 16

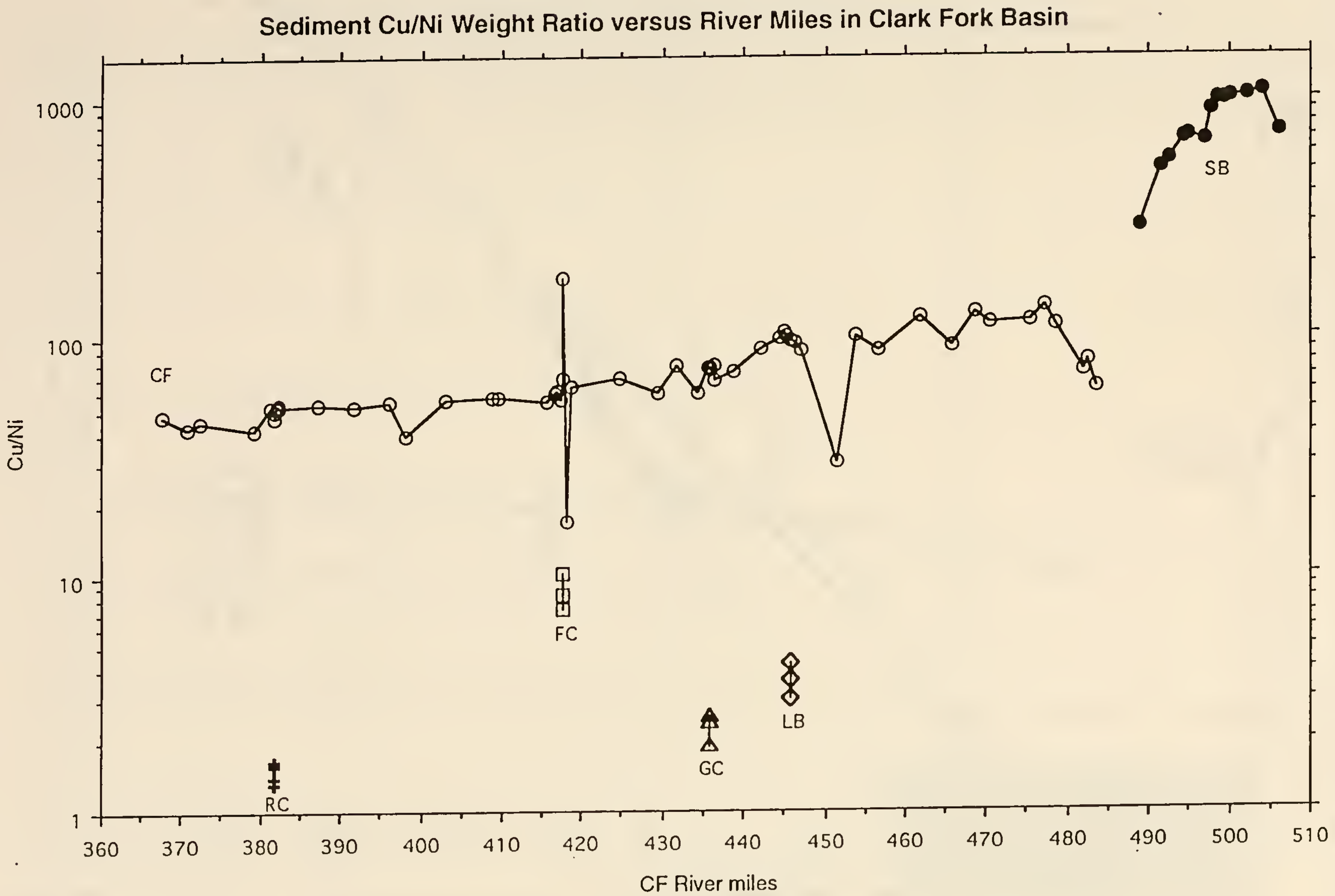
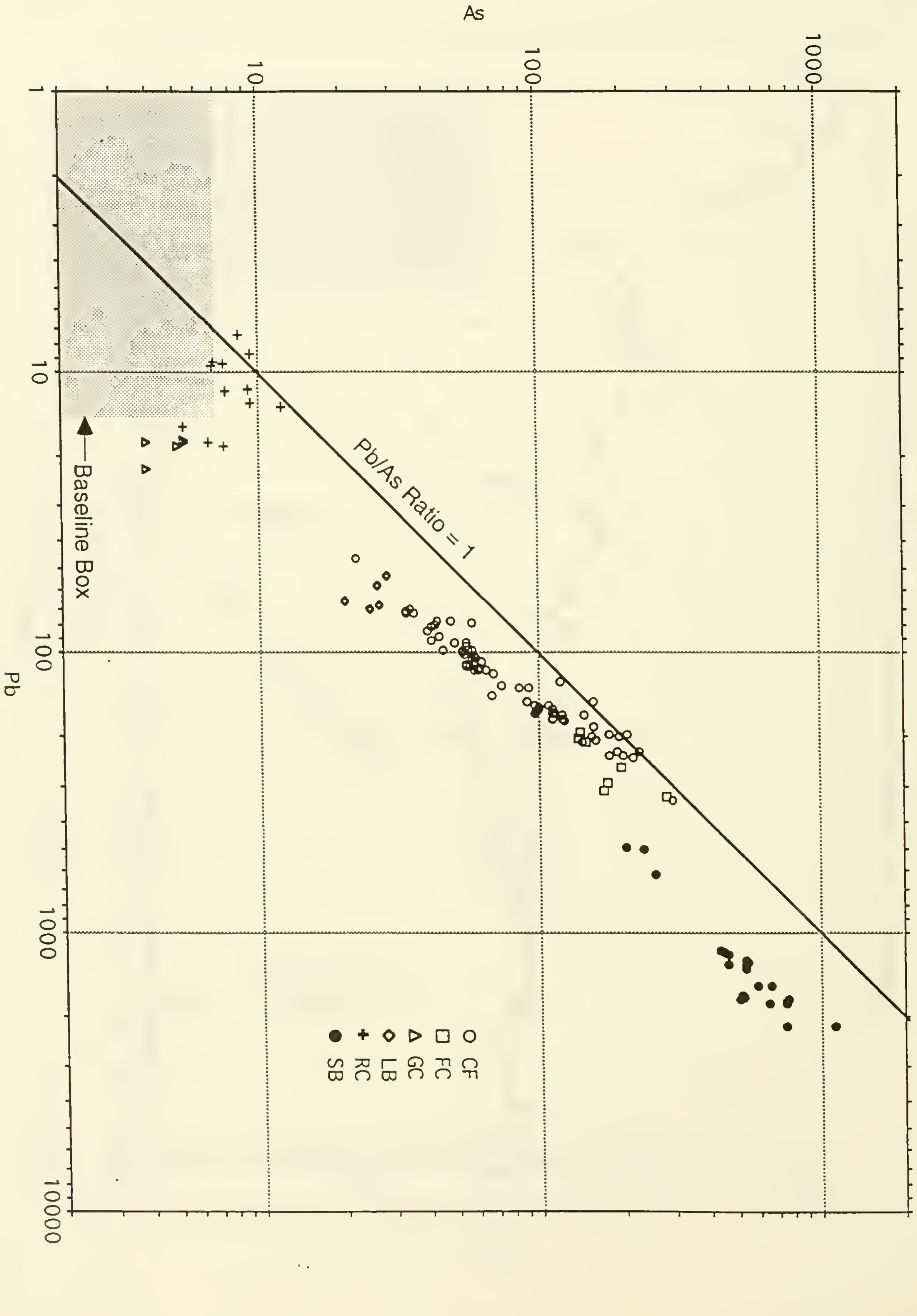
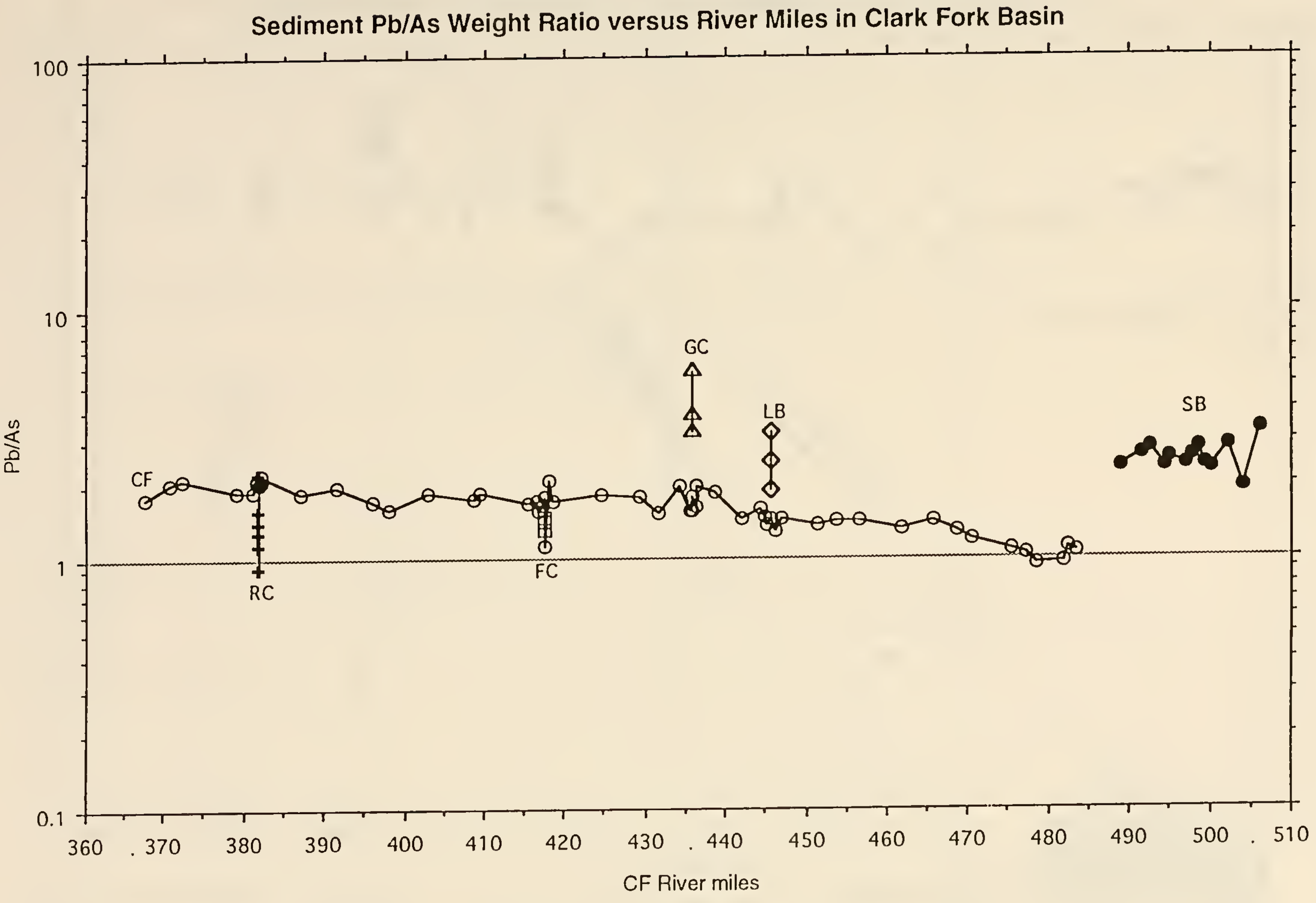

Sediment Cu/Ni Weight Ratio versus River Miles in Clark Fork Basin
Cu/Ni
1000
100
10
1
360
370
380
390
400
410
420
430
440
450
460
470
480
490
500
510
CF River miles
CF
SB
FC
GC
LB
RC

Figure 16a



Scattergram of Lead vs Arsenic

Figure 17



Sediment Pb/As Weight Ratio versus River Miles in Clark Fork Basin

Figure 17a

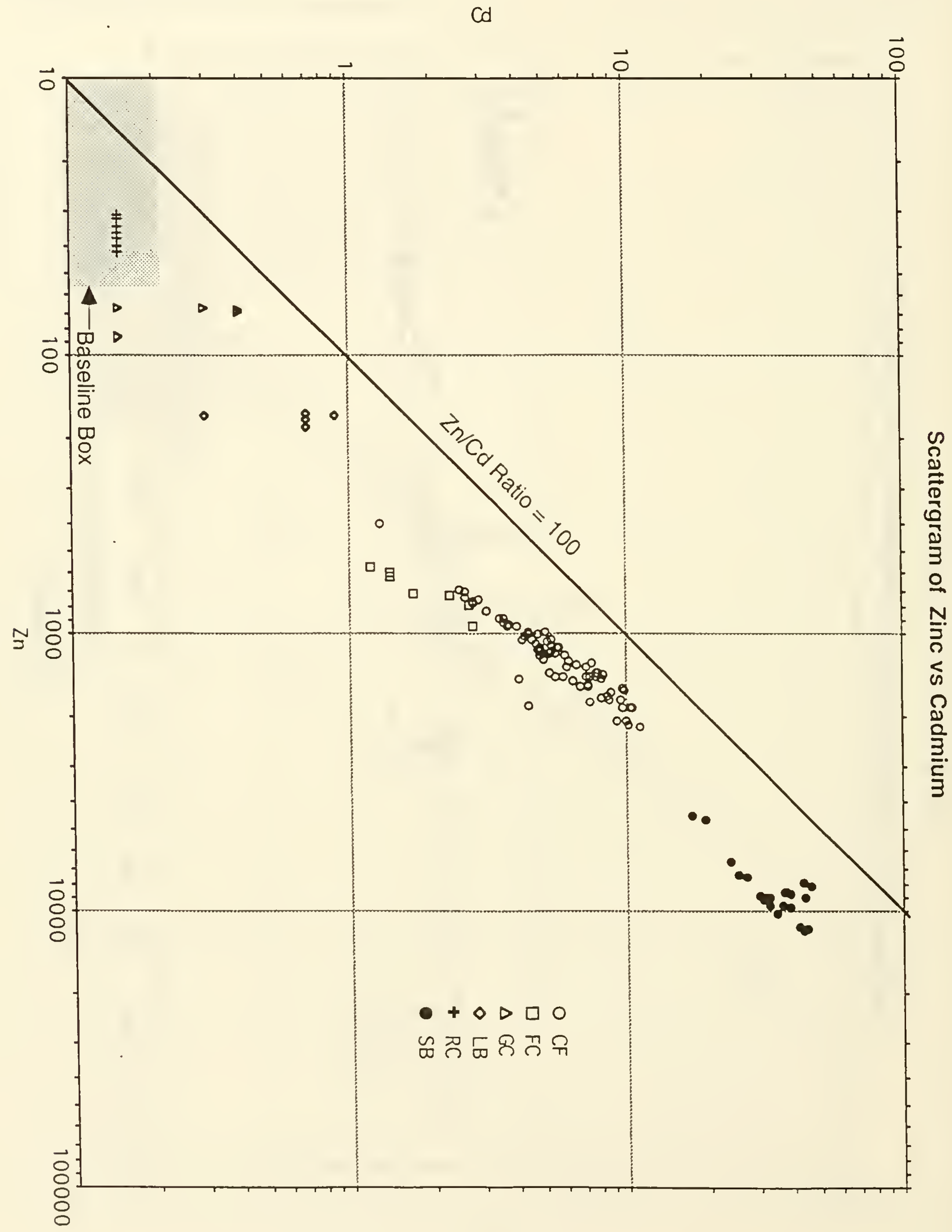

Scattergram of Zinc vs Cadmium
Cd
100
10
1
Zn
10
100
1000
10000
100000
Zn/Cd Ratio = 100
Baseline Box
CF
FC
GC
LB
RC
SB

Figure 18

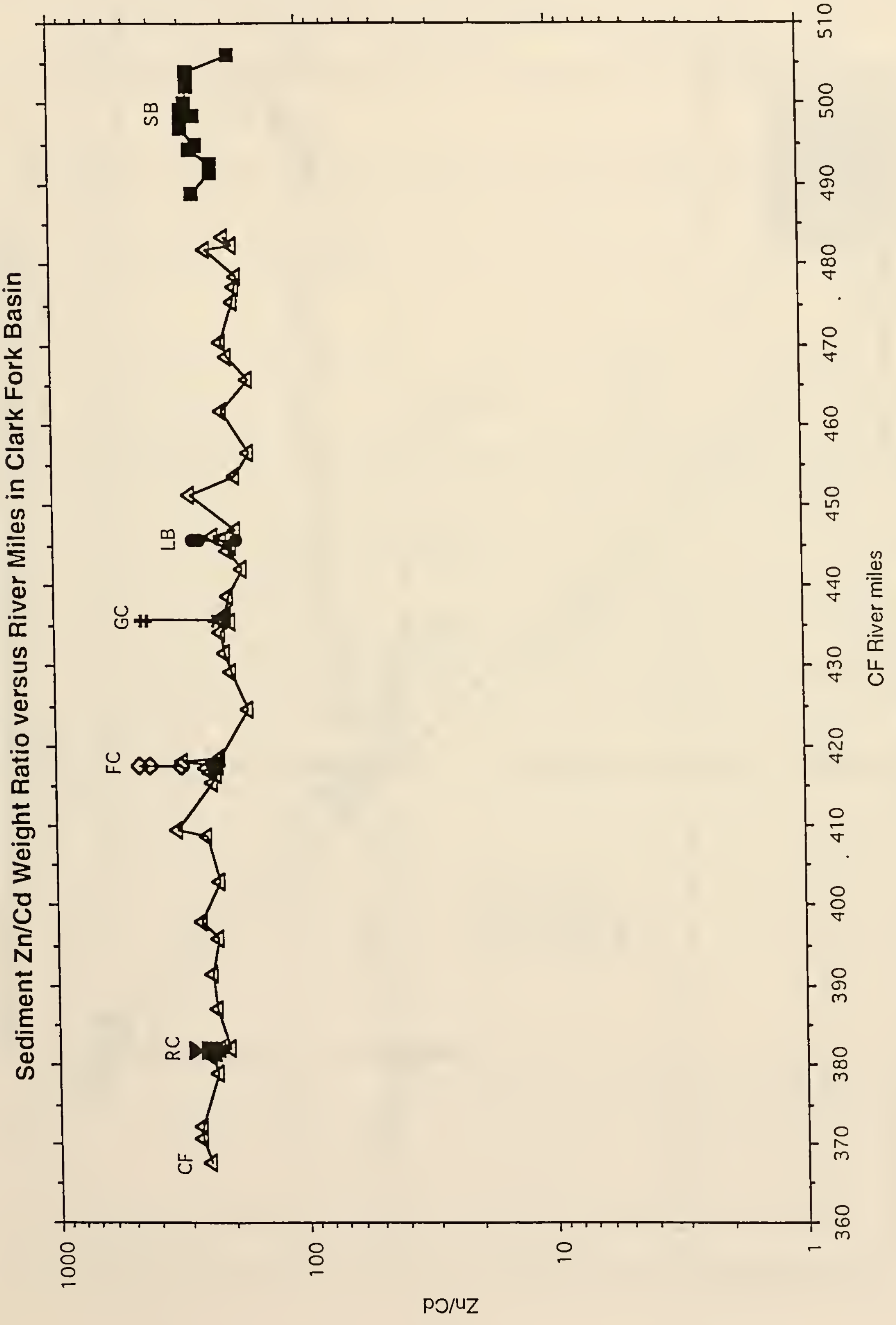

Sediment Zn/Cd Weight Ratio versus River Miles in Clark Fork Basin
Zn/Cd
1000
100
10
1
360
370
380
390
400
410
420
430
440
450
460
470
480
490
500
510
CF River miles
CF
RC
FC
GC
LB
SB

Figure 18a

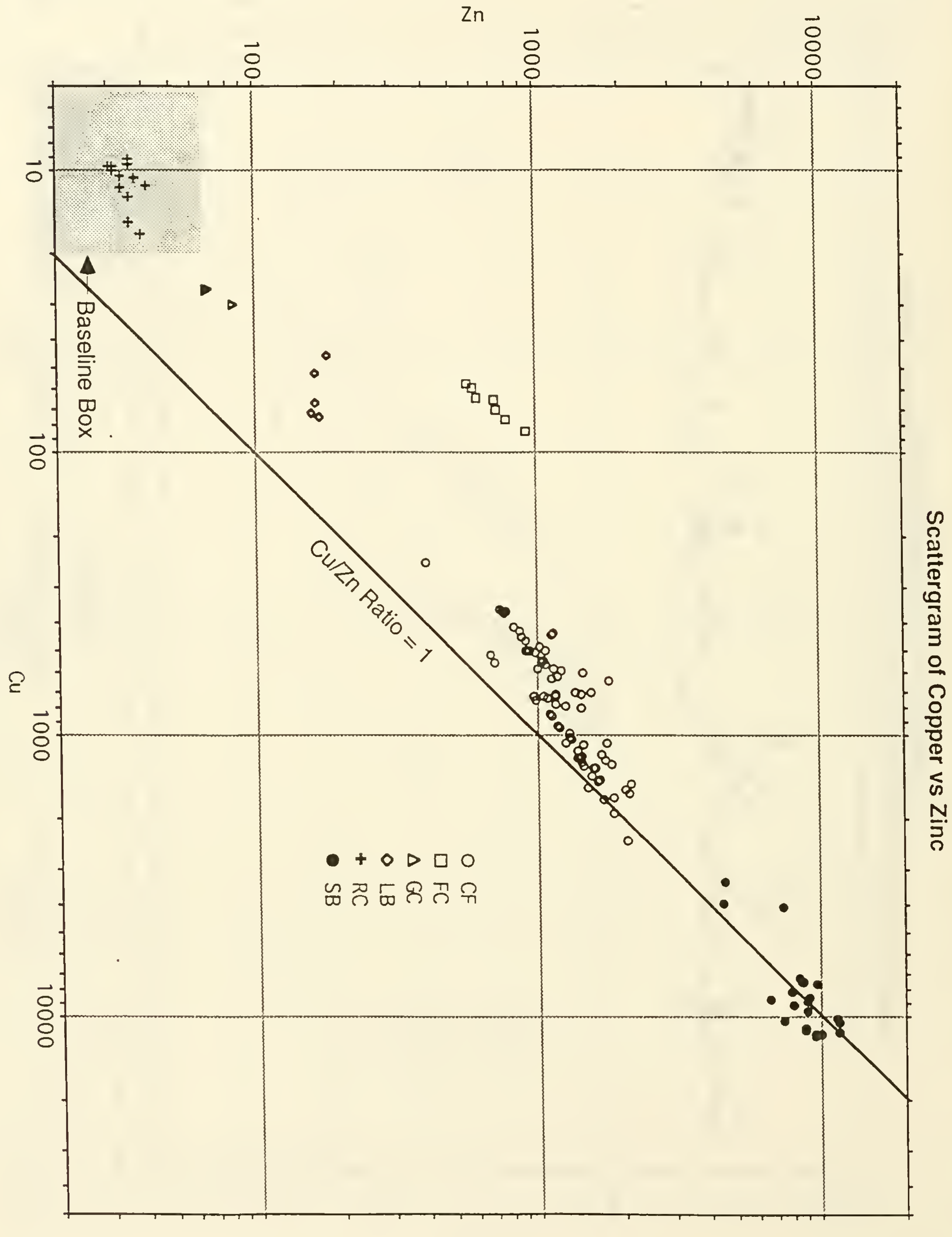

Scattergram of Copper vs Zinc
Zn
10000
1000
100
Cu
10
100
1000
10000
Cu/Zn Ratio = 1
Baseline Box
○ CF
□ FC
△ GC
◇ LB
+ RC
● SB

Figure 19

Sediment Cu/Zn Weight Ratio versus River Miles in Clark Fork Basin

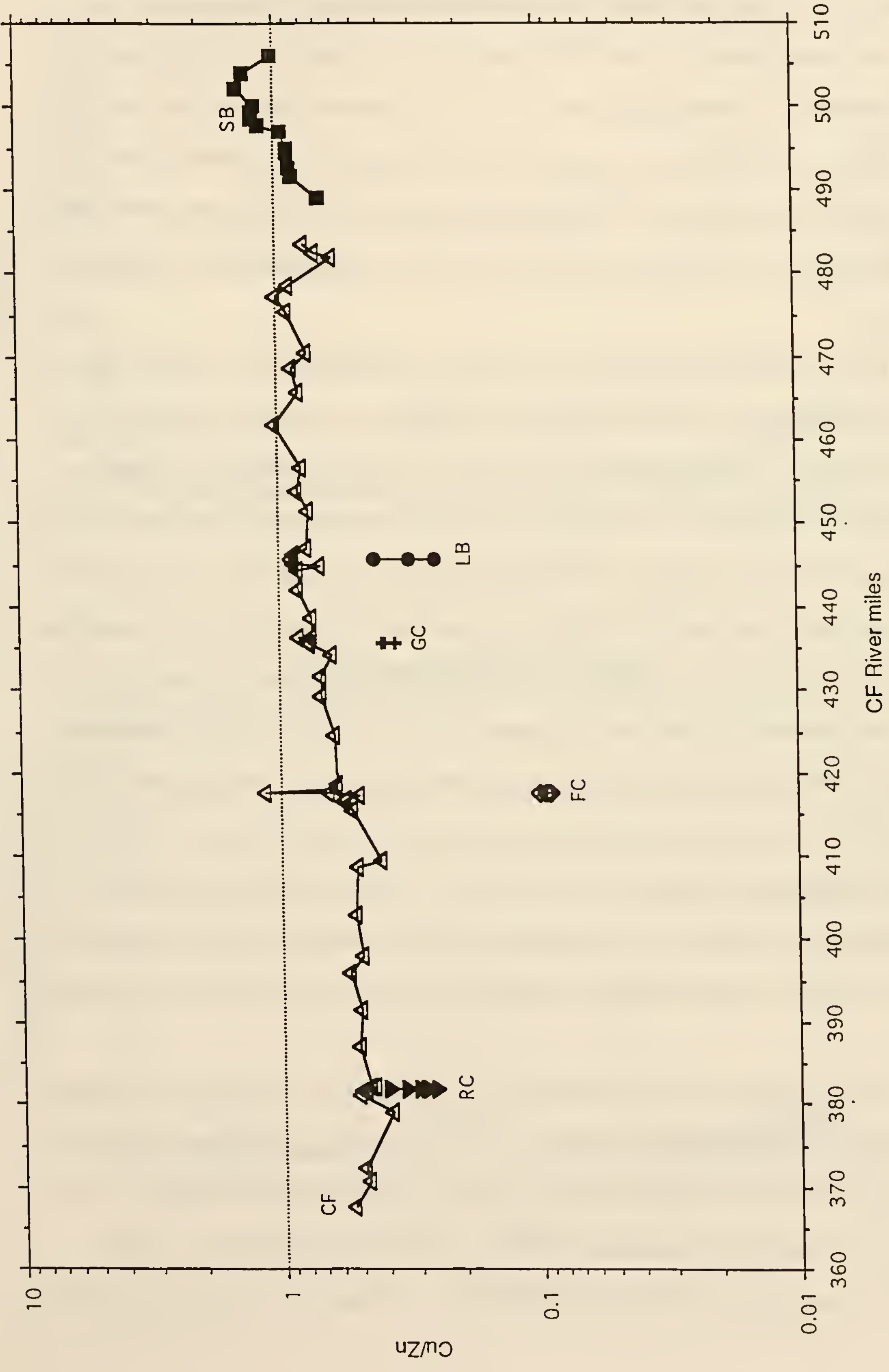
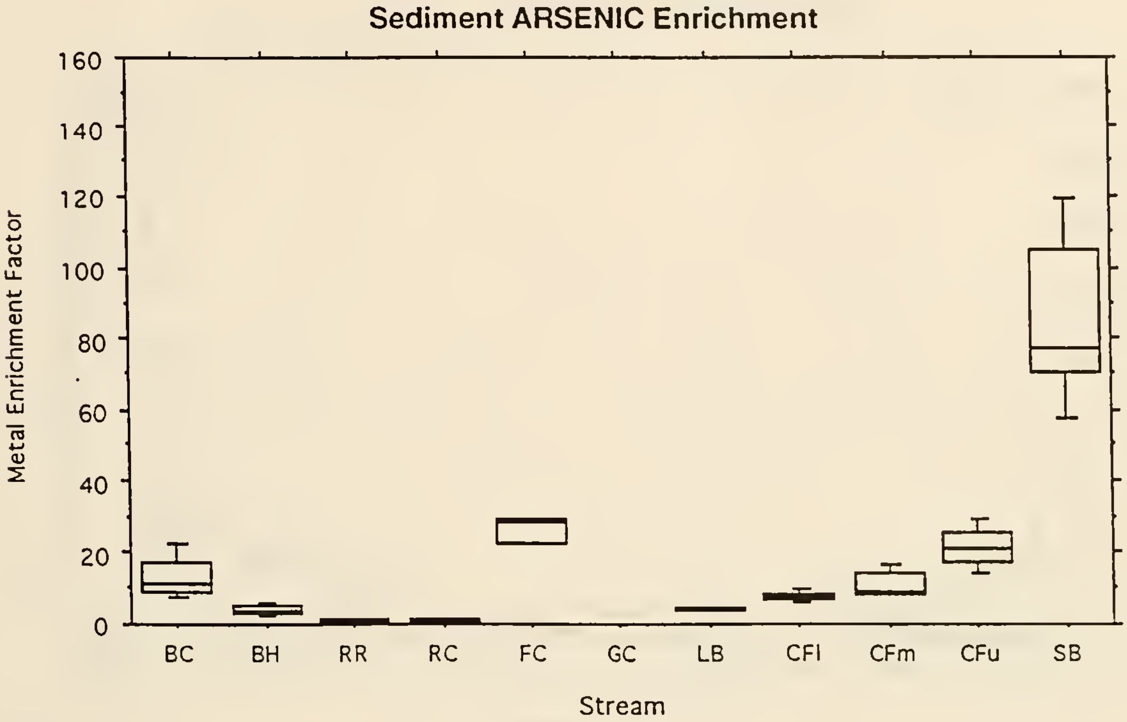


Figure 19a

most straightforward approach is to simply compare the concentration in a given sediment to an established baseline concentration. This approach was used in the presentation of Clark Fork basin trends above and is fully summarized in boxplots by stream (Figures 20-22). Remembering that the Ruby River, Rock Creek, and Gold Creek make up our local baseline, by virtue of their low concentrations and similarity to average abundances in comparable earth materials. The degree of enrichment in each stream is readily apparent in these boxplots.

The overwhelming picture is of extreme contamination of Silver Bow Creek sediments and the downstream regression of this contamination in the Clark Fork River. Median contaminant metal levels in Silver Bow Creek are two orders of magnitude or more above baseline—arsenic and lead are enriched about 80 to 100 times baseline, cadmium and zinc are enriched more than 150 times, and median copper enrichment approaches 500 times the local baseline. In the Clark Fork River, median arsenic and lead enrichment increase from 7.2 and 6.0 respectively in the lower segment to 20.3 and 11.4 in the uppermost segment. Over the same length of river, cadmium and zinc enrichment increase from about 19 and 18, respectively, to more than 35 and 27 times baseline, and copper enrichment increases from 25 fold to 65 fold enrichment. These two "test" streams are clearly very enriched in all five metals discussed above with the general order of magnitude of enrichment being Cu >> Cd > Zn > As >> Pb.

Another approach to determining metal enrichment is based on comparison of ratios of different trace metals. Many researchers have found that the abundance of trace metals depends on particle size and find increased concentration of metals in fine sediments (Gibbs, 1973,1977; Jenne et al., 1980; Horowitz and Elrick, 1987; Horowitz, 1991). We have directly limited particle


Sediment ARSENIC Enrichment
Metal Enrichment Factor
160
140
120
100
80
60
40
20
0
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

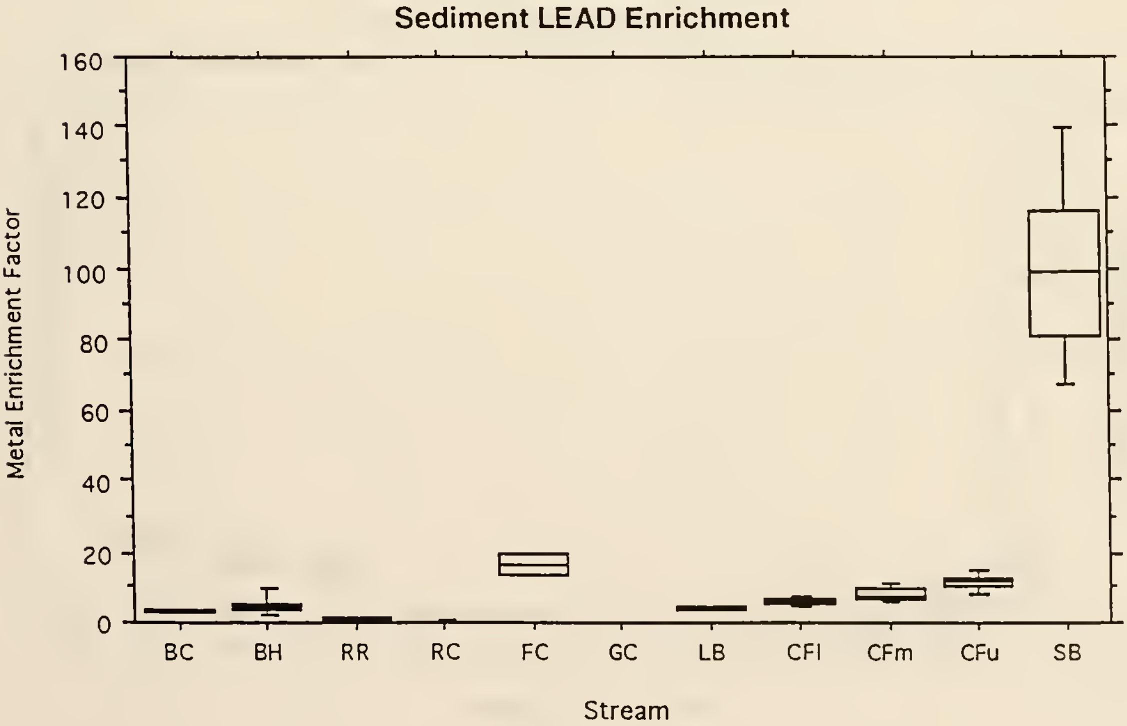
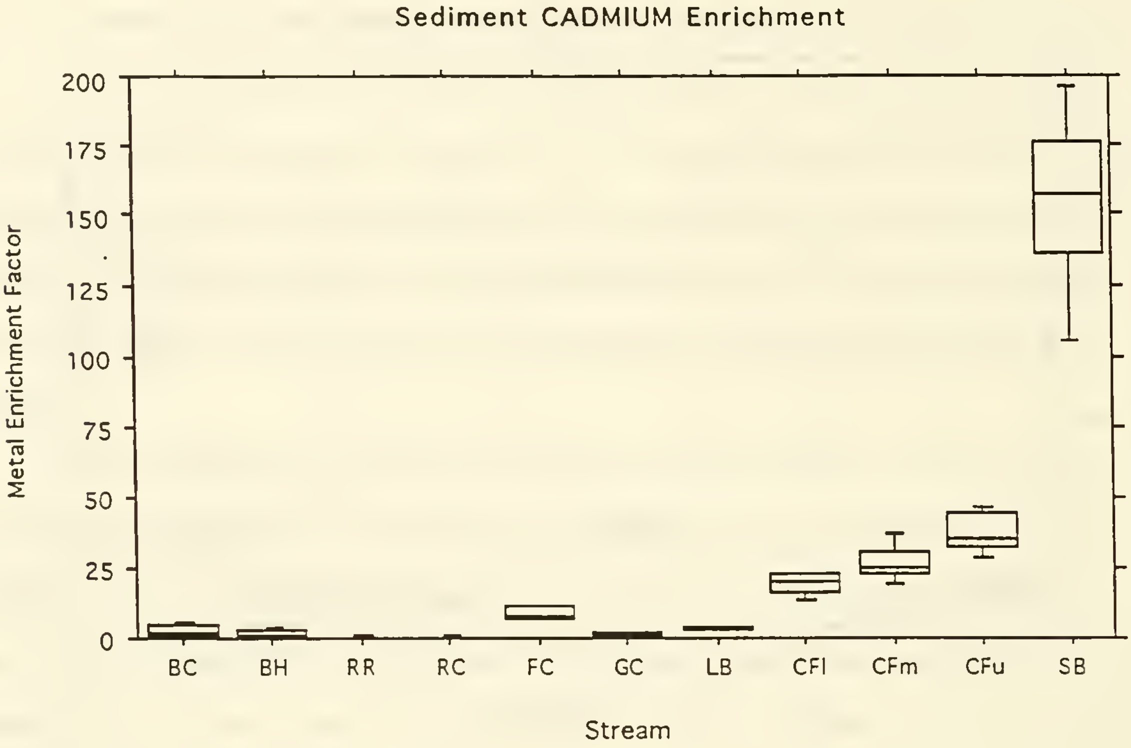

Sediment LEAD Enrichment
Metal Enrichment Factor
160
140
120
100
80
60
40
20
0
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

Figure 20


Sediment CADMIUM Enrichment
Metal Enrichment Factor
200
175
150
125
100
75
50
25
0
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

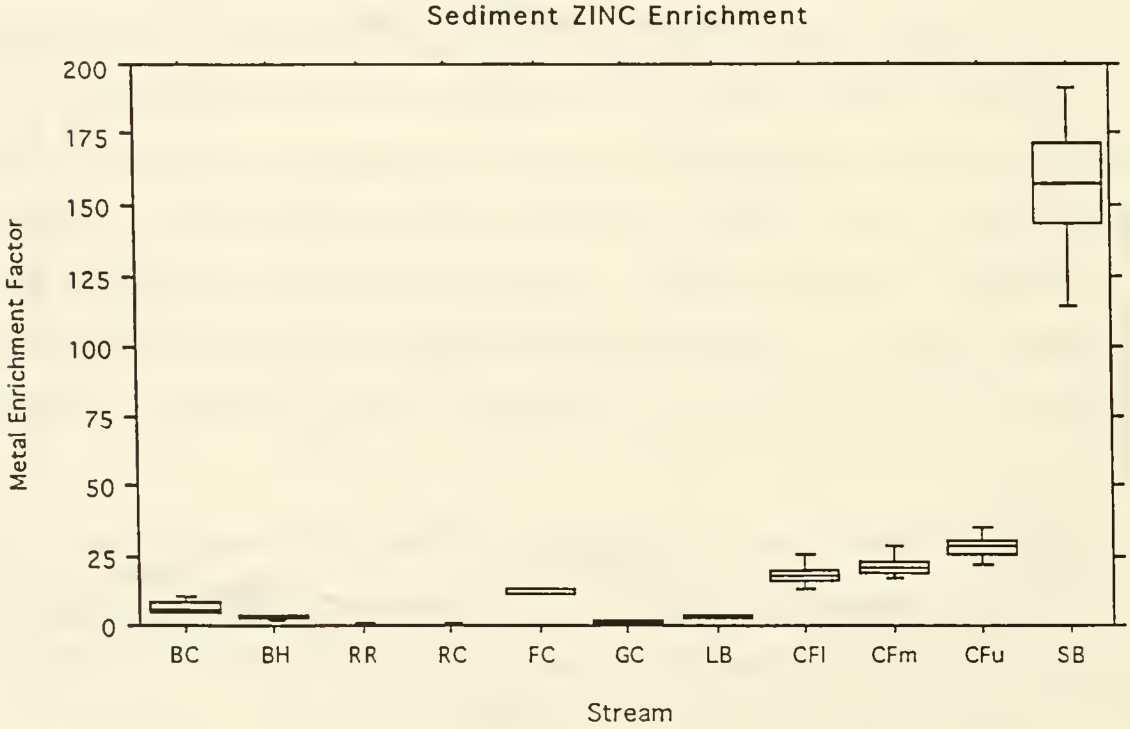
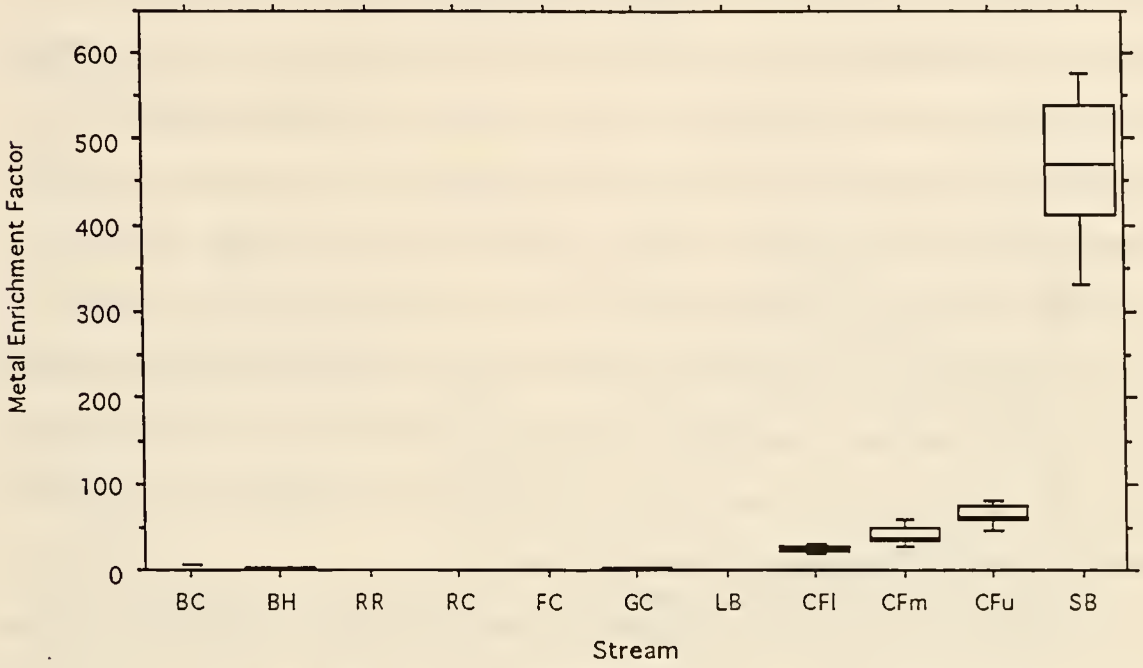

Sediment ZINC Enrichment
Metal Enrichment Factor
200
175
150
125
100
75
50
25
0
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

Figure 21


Sediment COPPER Enrichment

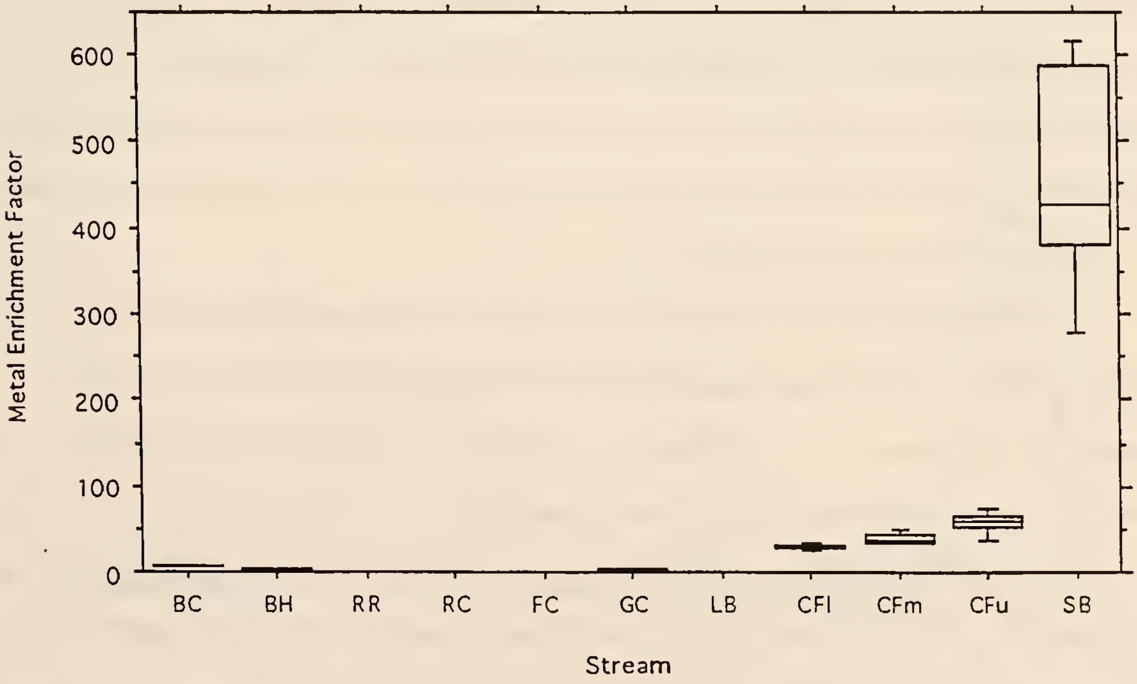
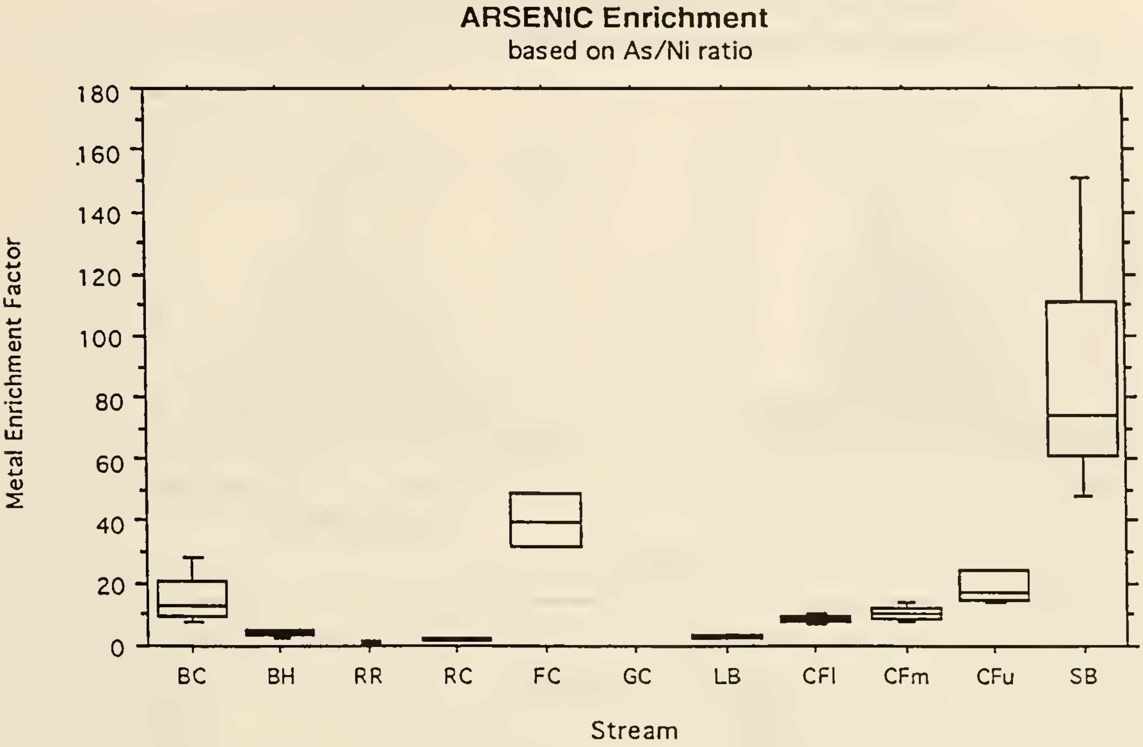

COPPER Enrichment
based on Cu/Ni ratio

Figure 22

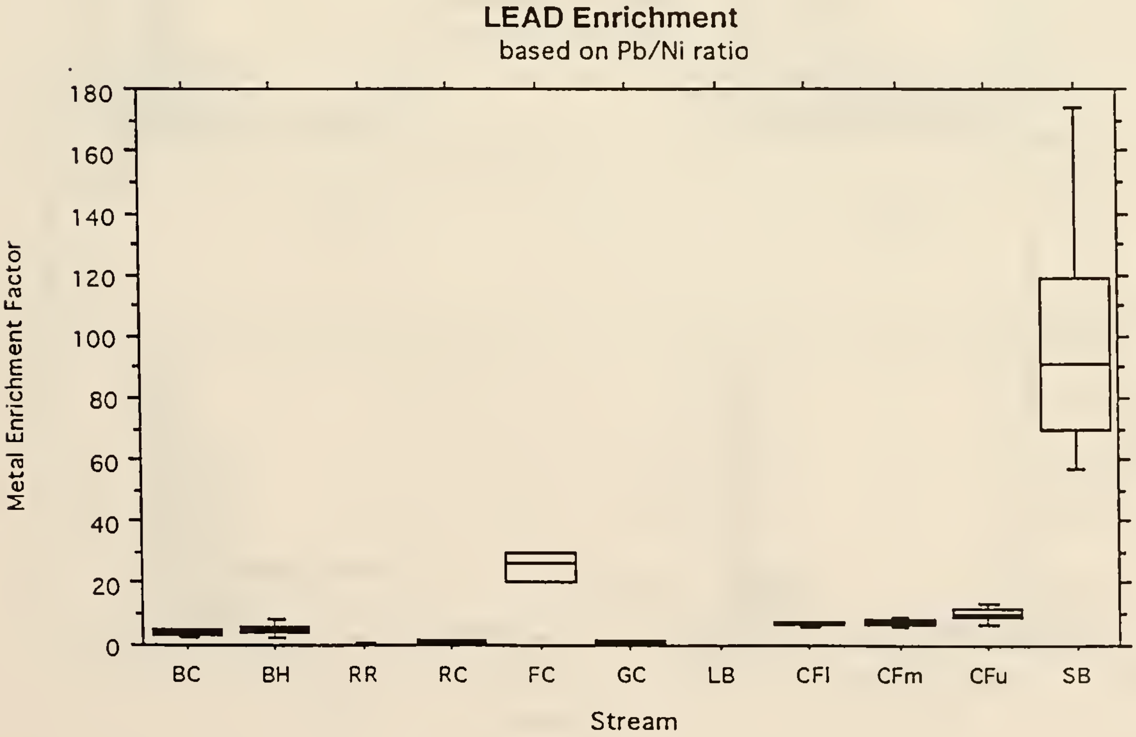
size effects in our samples by wet sieving them through a 63 μm mesh at the time of collection (see methods). Our comparisons are among the same size fraction of sediments from all streams and our local baseline is for concentrations in such fine bed sediments. However, in lieu of restricting sediment samples to a particular size fraction, some researchers use a conservative element such as aluminum (Windom et al., 1989) or lithium (Loring, 1990) to normalize trace metal concentrations, and use comparison of ratios to these conservative elements to indicate metal enrichment. This works with aluminum because it is a primary constituent of alumino-silicate minerals which make up clays that usually predominate in fine sediments, and so aluminum serves as a surrogate for fine–sediment content in a sample.

We use metal/Ni ratios to determine metal enrichment, and also to calculate enrichment factors by normalizing these ratios to the metal/Ni for our local baseline (Figures 22-24). Nickel is used because of its apparently conservative behavior in the streams studied (an alternative to aluminum whose analytical recovery may be low). Among the measured analytes, only nickel shares with aluminum an approximately normal distribution of the data for all sites sampled (Figures 25&26). Nickel concentration averages very near local baseline and typical earth material abundances.

Metal enrichment factors using metal/Ni ratios are calculated by dividing the metal/Ni ratio for each sample by the average metal/Ni ratio, equally weighted by stream, for the three local reference streams established above (see section on determining geochemical baseline). The resulting metal enrichment factors (Figures 22-24) are almost identical to those above (Figures 20-22) and further support the above findings on contamination. Clearly, sediment metal concentrations in Clark Fork–Silver Bow sediments are far greater than would be the case in an uncontaminated river system in this region.

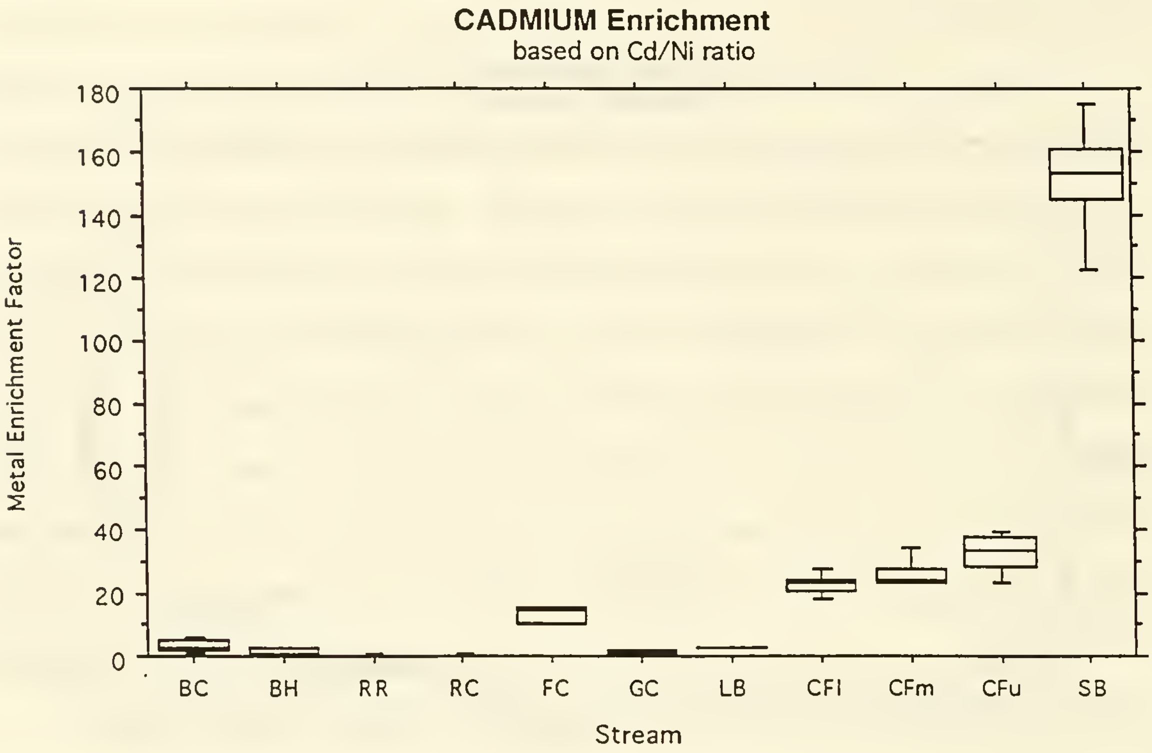


ARSENIC Enrichment
based on As/Ni ratio



LEAD Enrichment
based on Pb/Ni ratio

Figure 23


CADMIUM Enrichment
based on Cd/Ni ratio
Metal Enrichment Factor
180
160
140
120
100
80
60
40
20
0
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

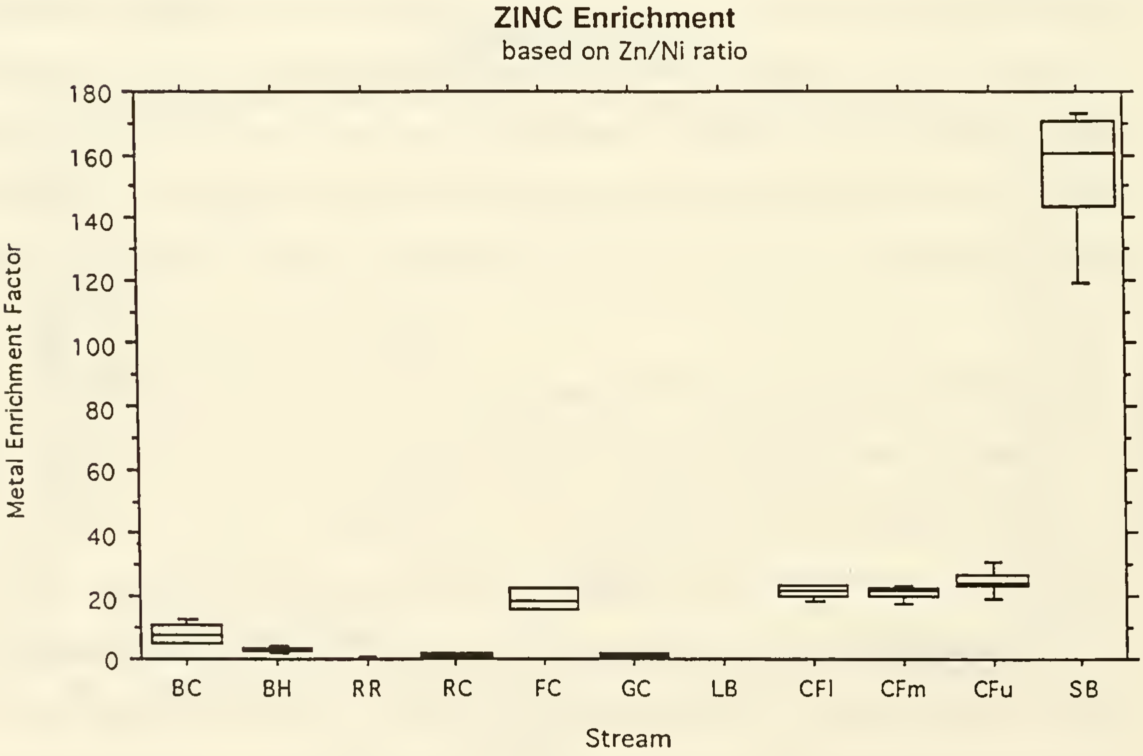

ZINC Enrichment
based on Zn/Ni ratio
Metal Enrichment Factor
180
160
140
120
100
80
60
40
20
0
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

Figure 24

Frequency Distributions of Sediment Analytes
All Sites combined

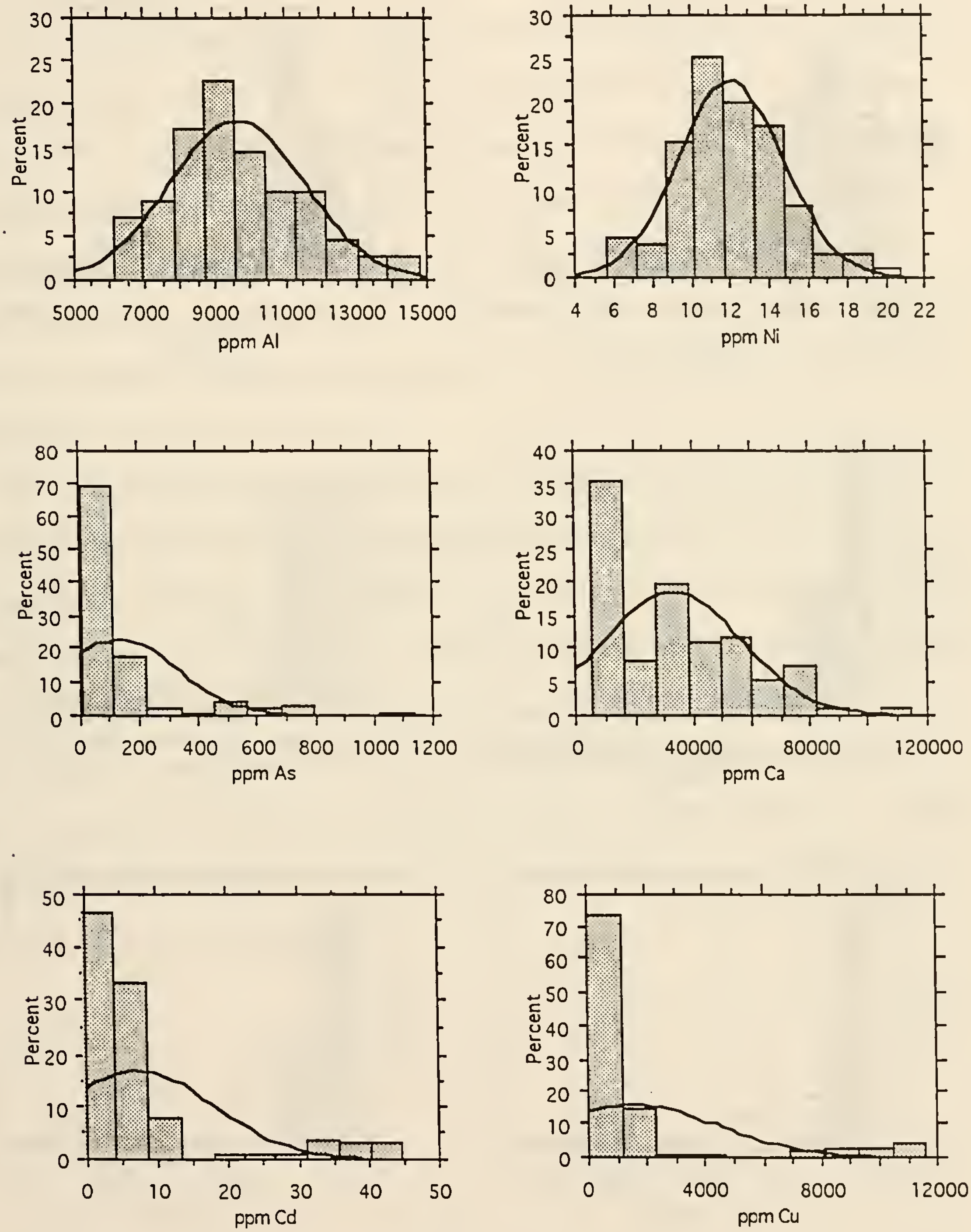


Figure 25

Frequency Distributions of Sediment Analytes
All Sites Combined

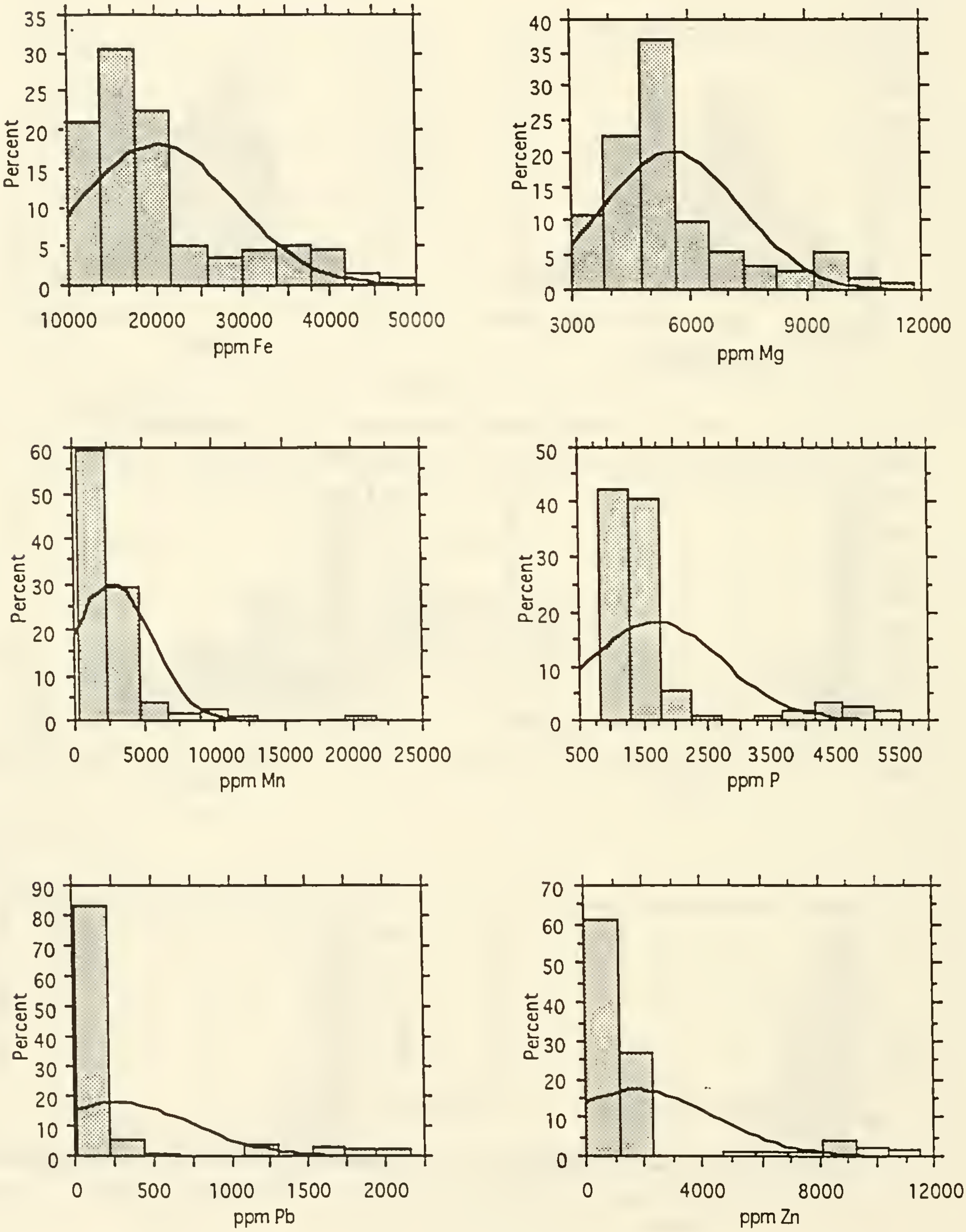


Figure 26

The obvious source of such extreme contamination is the large scale mining and smelting operations around Butte-Anaconda. The large extent of floodplain tailings deposits has been well documented (Brick and Moore, 1992). However, a detailed chemistry of floodplain deposits has only been determined along a 10 km stretch of the upper Clark Fork River floodplain (Nimick,1990); our upper division of the Clark Fork River includes this stretch. Nimick identified eleven stratigraphic units in the floodplain. Of these, five units are essentially pure tailings transported from upstream and deposited. One is reworked tailings, more recent deposits which consist of tailings mixed with older, cleaner sediment. The other five units are pre-mining, non-tailings deposits.

Enrichment factors based on metal/Ni ratios for As, Cu, Pb and Zn were calculated for the reworked and pure tailings deposits of Nimick (1990) using his data (his Cd data were insufficient to calculate a median enrichment factor). Floodplain deposits of pure tailings possess enrichment factors as high or higher than those for the bed sediments from the upper division of the Clark Fork River (Table 12), and reworked tailings have enrichment factors of the same order of magnitude as the bed sediments. Based on this comparison, floodplain tailings deposits alone can account for the level of contamination observed in the Clark Fork River sediments.

Table 12
Comparison of Floodplain and River Bed Enrichment Factors

Contaminant	Pure Tailings n=39	Reworked Tailings n=13	Upper CF Bed Sediments n= 19
As	192	nd	17
Cu	124	37	59
Pb	62	10	10
Zn	27	16	25

nd = no data. Values are medians. Floodplain metal/Ni enrichment factors calculated from Nimick's total analysis results of samples taken from pure tailings, units 2-6, and reworked tailings, unit 1.

Contamination Index

Elevated concentrations of As, Cd, Cu, Pb, & Zn can be harmful to aquatic life. In the Clark Fork River system we have shown these five metals are elevated well above baseline and can be considered contaminants. Any time a number of contaminants are considered it becomes both desirable and problematic to assess their combined effect on biota. However, the degree of harm is not directly related to enrichment levels because of differences in the toxicity of various contaminants. Therefore, it is necessary to weight sediment contaminant concentrations by some measure of their relative toxicity in order to compare or combine them. We develop a contamination index which combines contaminants on the basis of their relative toxicity.

The National Oceanic and Atmospheric Administration (NOAA) recently published a report which compiles data of biological effects of sediment contamination documented since the 1984 inception of its National Status and Trends program (Long and Morgan, 1991). The authors define consensus threshold sediment concentrations for *probable* biological effect (ER-M) based on preponderance of evidence from numerous studies. For each contaminant considered, they assembled a ranked list of minimum sediment concentrations at which a biological effect was observed or predicted. Prior to ranking the data, studies were screened to meet a set of applicability criteria. Their ER–M values were then set at the 50th percentile in the list of the ranked data for each contaminant (values for As, Cd, Cu, Pb, and Zn appear in Table 13).

Long and Morgan (1991) also report a relative degree of confidence in each of their ER-M values for each analyte, taking into account agreement among studies using different approaches to determine effects-based sediment concentrations, coherence in the data, variety of geographic areas represented,

Table 13
Relative Toxicity of Five Sediment Contaminants

Contaminant	ER-M[1]	Confidence in ER-M[2]	# of Studies[3]	Relative Toxicity[4]
As	85 ppm	poor	16	.106
Cd	9 ppm	high	36	1
Cu	390 ppm	relatively high	51	.023
Pb	110 ppm	high	47	.082
Zn	270 ppm	relatively high	46	.033
weighted sum [5]	45			

[1] Threshold sediment concentration for probable biological effects, data from NOAA Technical Memorandum NOS OMA 52, August 1991, by Long and Morgan

[2] In the judgment of Long and Morgan.

[3] Number of metal/species combinations studied, more than one 'study' may come from a single report.

[4] Relative Toxicity is simply the ratio of the Cd ER-M value to that of each contaminant X, ie. Cd ER-M/X ER-M = relative toxicity of X, where X represents the contaminant of interest. Cadmium is used as the basis because it has the lowest ER-M of the five contaminants considered here.

[5] Used to calculate contamaination index, see text.

and similarity of ER-M to an overall apparent effects threshold derived before the data were ranked. Where the data exhibited all of the above the authors placed a high degree of confidence in their ER-M values (Table 13).

We use ER-M values for As, Cd, Cu, Pb, and Zn to construct a contamination index for the sediments in our study, which we term CI. CI is designed to combine the probable biological effects of sediment As, Cd, Cu, Pb and Zn into a single measure of danger to aquatic life. To combine effects in this way it is necessary to account for differences in 'toxicity' among contaminants, therefore a relative toxicity was derived using the thresholds of Long and Morgan (1991). We define relative toxicity of a contaminant as the ratio of ER-M values for a given contaminant to the ER-M value for cadmium (9 ppm). Cadmium is chosen as the basis because it has the lowest ER-M among contaminants considered here. For the purpose of combining metal effects, the equivalent concentration of each of these five contaminants is calculated as their sediment concentration weighted by their relative toxicity, in other words 390 ppm Cu is equivalent to 9 ppm Cd, etc.

The final step to calculate CI is to divide the summed equivalent concentrations by the weighted sum of the ER-M values (45 ppm). This results in an index which possesses a value of one when all five component contaminants are at their respective ER-M values (probable biological effects threshold). Combined CI values were calculated for each sample site and then averaged for each stream (or stream division in the case of the Clark Fork River) and plotted in a bar chart (Figure 27). Clearly the level of contamination in the Clark Fork River mainstem is above levels that cause deleterious effects on biota; in Silver Creek the situation is extreme. The only other stream studied with a CI above one is Flint Creek.

In constructing CI no attempt is made to consider interaction of multiple contaminants, although multiple stresses are generally at least additive, often they are synergistic. That is, the effect of a combination is often greater than their sum. Also, in the CI, a below ER-M concentration of one contaminant will offset a greater than ER-M concentration of another. For these reasons we view our sediment contamination index as a conservative indicator of effects on the biota.

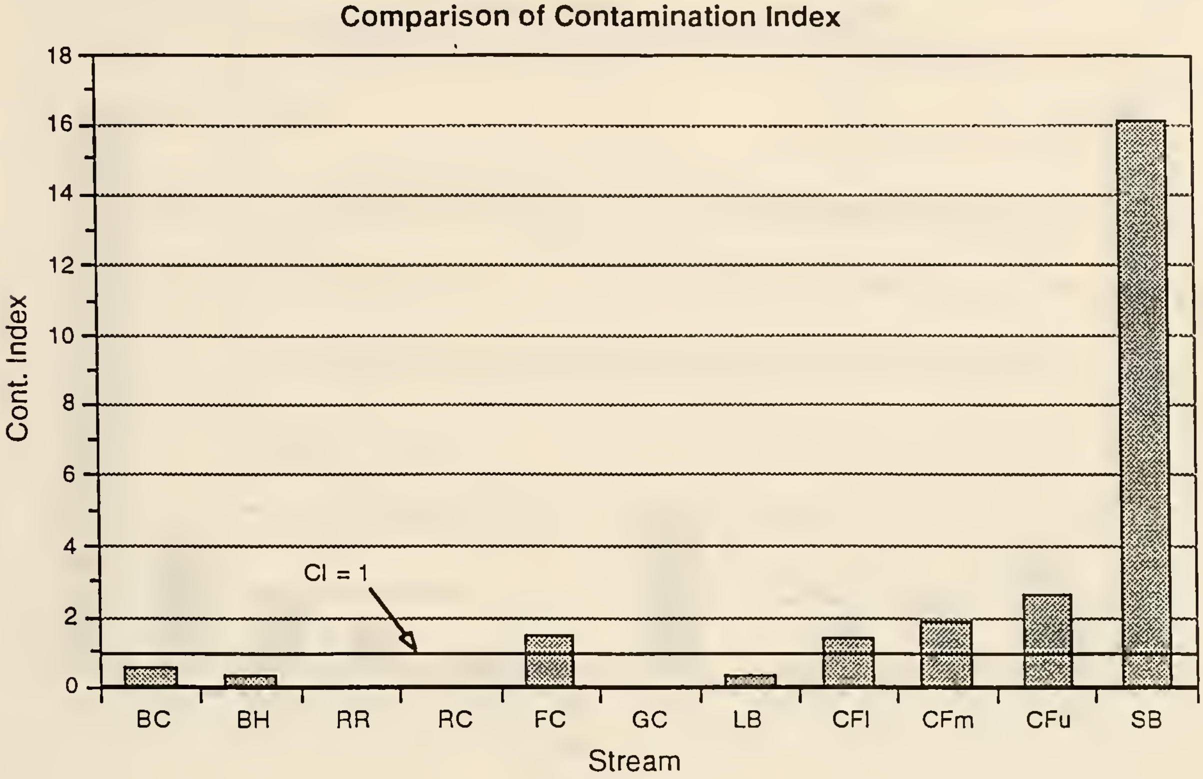
Because of the differences among study streams in individual contaminant concentrations, and the limitations of a simple sum that were noted above, it is informative to split the CI into its component parts by calculating a CI for each contaminant separately. These are denoted by Me-CI, where Me represents a single contaminant. The Me-CI is calculated by dividing the contaminant concentrations that were measured in each sediment sample by the respective ER-M value. For example, a Cd-CI value of one results when the concentration of cadmium equals its ER-M value—i.e., the sediment Cd concentration is at the threshold of probable biological effect. Whereas, a Cd-CI value of 2 would mean that the average cadmium concentration in the sediment is twice the level of probable effect on aquatic life. These values are then averaged within a stream (or stream segment) to arrive at five individual contaminant indices, one for each of the five contaminants (Figures 27-29).

The importance of these individual contaminant indices lies in establishing differences in magnitude of the indices among streams and between contaminants. The relative differences among streams will remain valid even if the absolute magnitudes of the indices are substantially changed by revision in Long and Morgan's ER-M's. These indices again show that the probability of biological effect due to sediment contamination is extremely high in Silver Bow Creek, and the indices step down logically through the upper, middle and lower divisions of the Clark Fork River (Figures 27-29). Also evident is the rank in the Clark-Fork River system, by the degree that threshold of probable biological effect is exceeded, of these five contaminants: Zn > Cu > Pb > As > Cd.

Using Me-CI greater than one as a threshold for biological effect and comparing the different contaminants shows a range in importance for injury to aquatic life in these streams. By this analysis cadmium is of concern only in Silver Bow Creek (Figure 29). Arsenic and lead contribute to biological effects mainly in the upper reaches of the Clark Fork River, in Silver Bow Creek and in Flint Creek (Figure 28). By far the highest individual contamination indices are found in the Clark Fork–Silver Bow, where Cu and Zn-CI values are both over twenty times the threshold for probable biological effect (Figures 27&29). Although Zn-CI is over one in Flint Creek, it is less than in the lowest, and least contaminated, segment of the Clark Fork. Furthermore, Cu-CI is above one only in the Clark Fork River and Silver Bow Creek—which sets these two streams apart from all others studied.

The composite CI (Figure 27) reflects this dominance of copper and zinc in the contamination of sediments in the Clark Fork River drainage downstream of Butte-Anaconda mining. Using this index alone as a measure of probable biological effects, shows that the only other significantly contaminated stream is Flint Creek, where the composite CI is driven by arsenic and lead concentrations (Figure 28). The primary danger to aquatic life in the Clark Fork River and Silver Bow Creek is from extreme Cu and Zn contamination.

To assess the usefulness of the contaminant index approach to rating biological effects of sediment contamination, we compare CI and Cu-CI to the richness of aquatic macro invertebrate taxa in the Clark Fork River and Silver Bow Creek reported by McGuire (1990). He presents taxa richness data collected in 1986, 1987, and 1988. We utilize data from nine of McGuire's sites for which we have corresponding sites, and match them to CI and Cu-CI values


Comparison of Contamination Index
Cont. Index
0
2
4
6
8
10
12
14
16
18
CI = 1
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

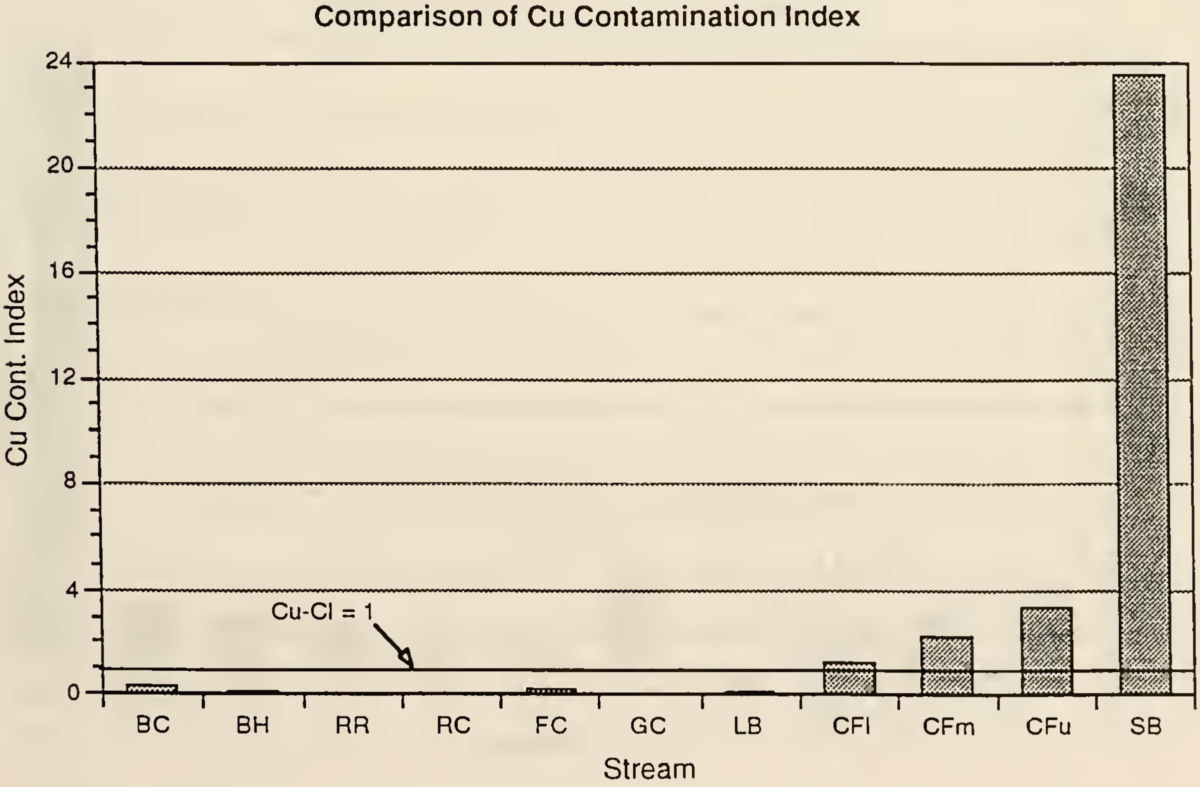
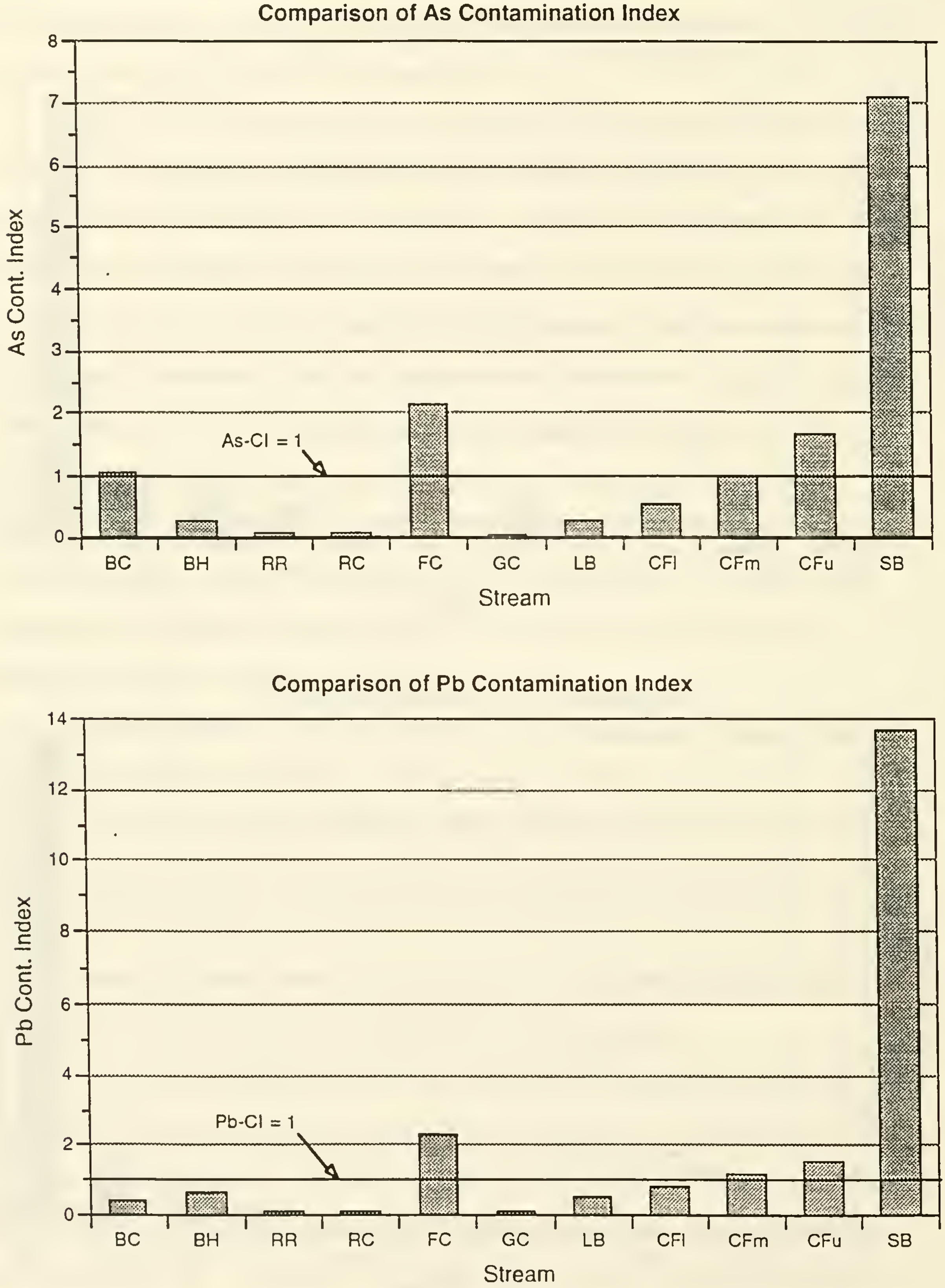
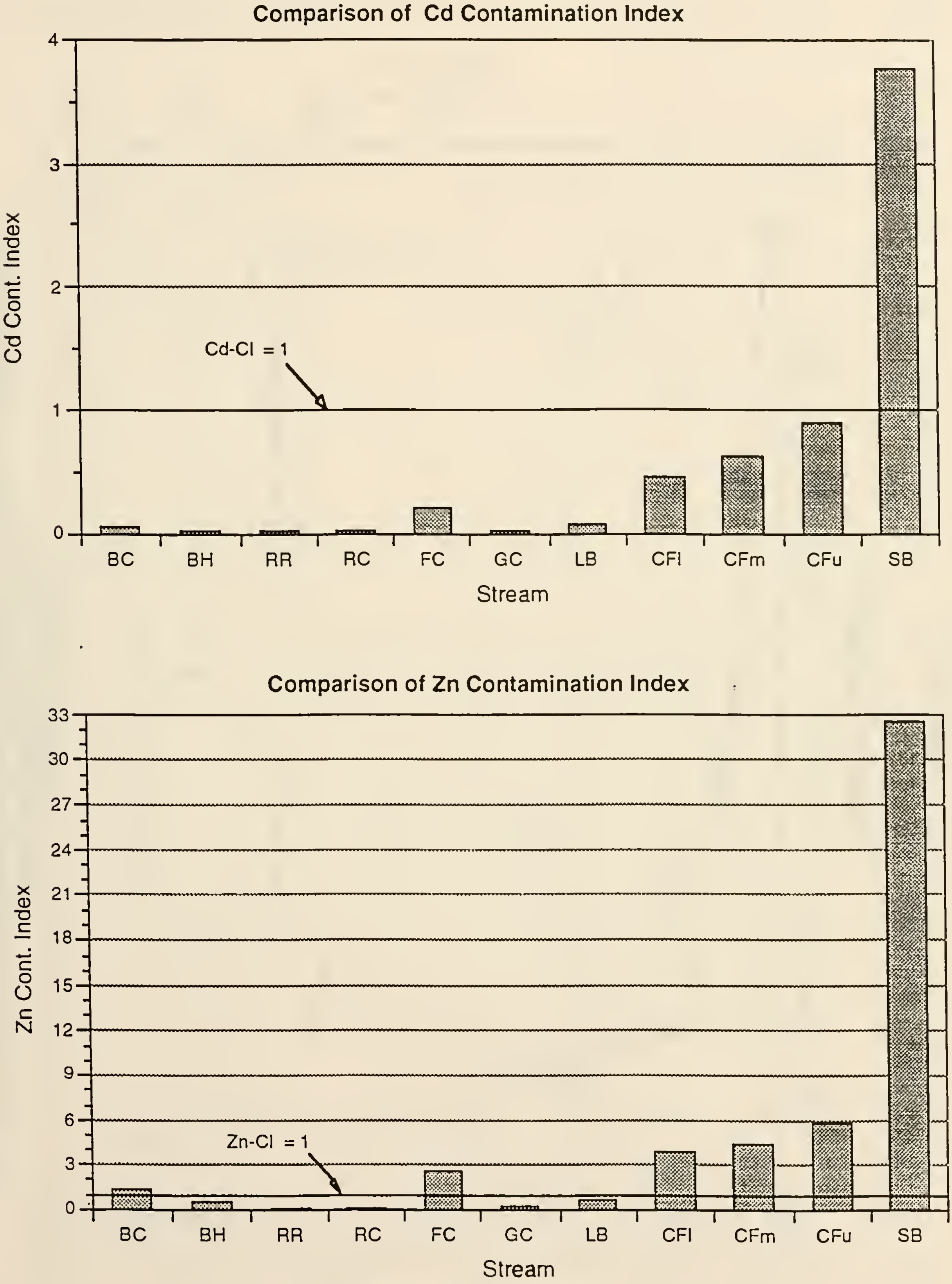

Comparison of Cu Contamination Index
Cu Cont. Index
0
4
8
12
16
20
24
Cu-CI = 1
BC
BH
RR
RC
FC
GC
LB
CFl
CFm
CFu
SB
Stream

Figure 27


Comparison of As Contamination Index

Comparison of Pb Contamination Index

Figure 28



Comparison of Cd Contamination Index

Comparison of Zn Contamination Index

Figure 29

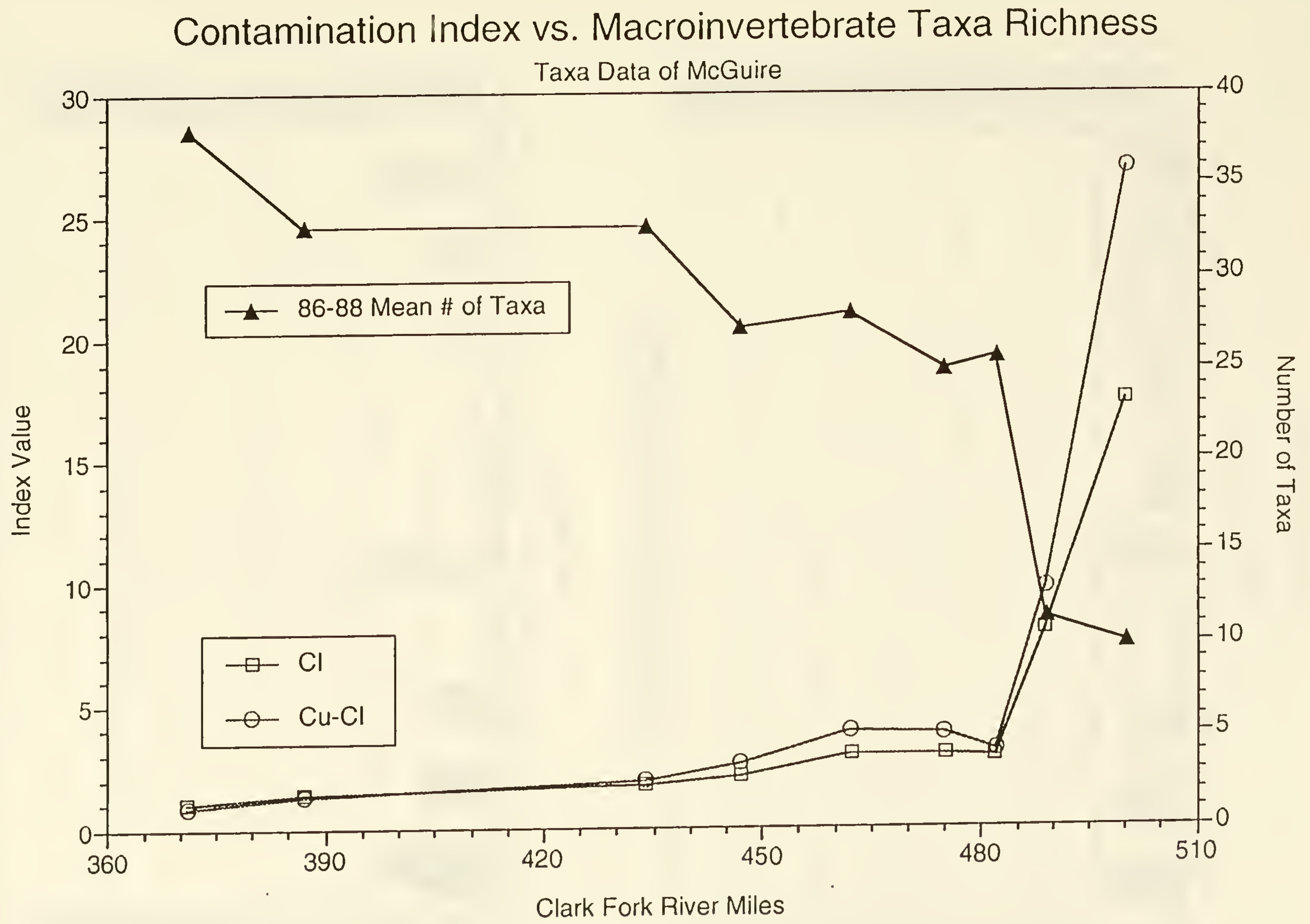

Contamination Index vs. Macroinvertebrate Taxa Richness
Taxa Data of McGuire
86-88 Mean # of Taxa
CI
Cu-CI
Index Value
0
5
10
15
20
25
30
Number of Taxa
0
5
10
15
20
25
30
35
40
Clark Fork River Miles
360
390
420
450
480
510

Figure 30

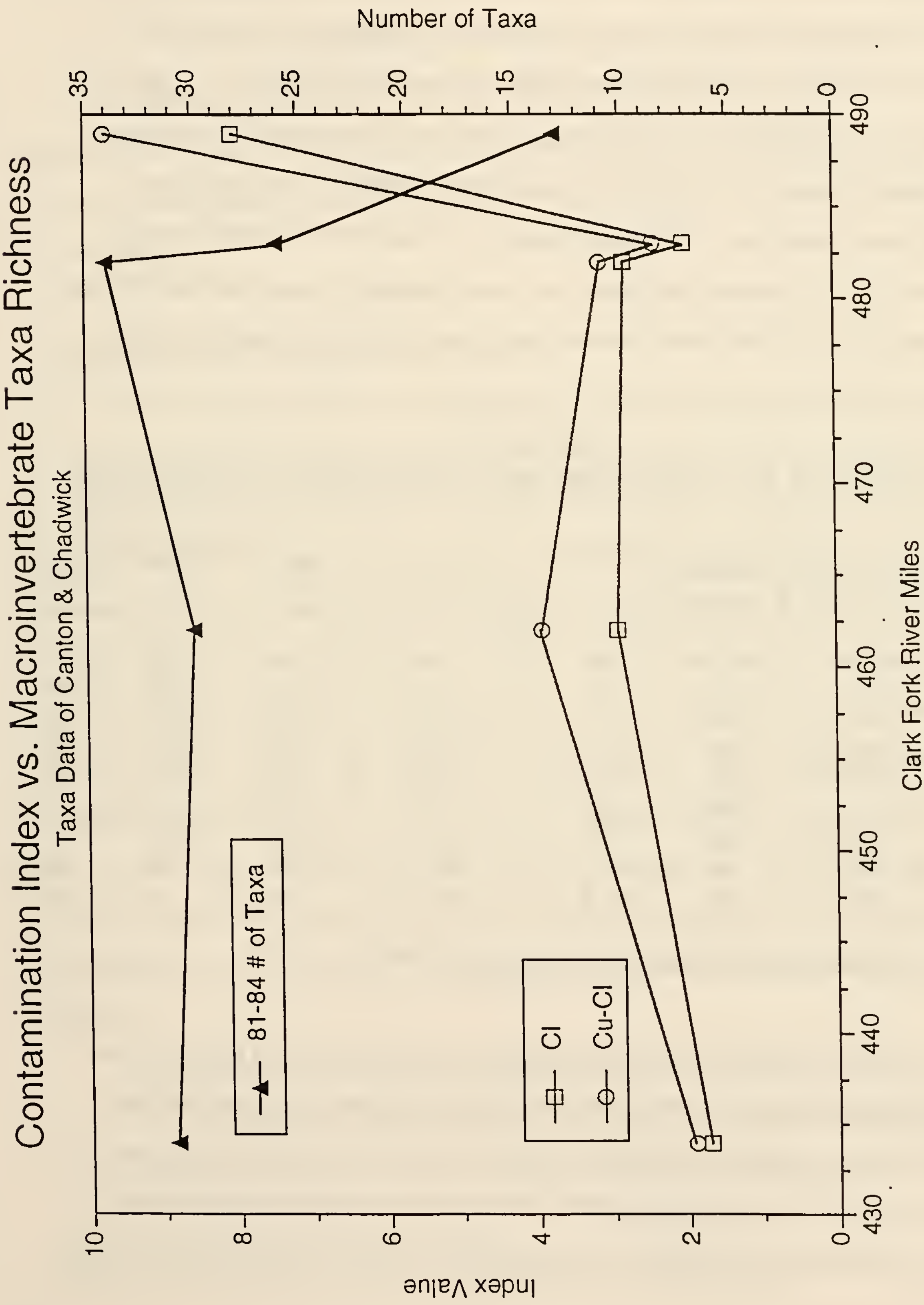

Contamination Index vs. Macroinvertebrate Taxa Richness
Taxa Data of Canton & Chadwick
Number of Taxa
35
30
25
20
15
10
5
0
Index Value
10
8
6
4
2
0
430
440
450
460
470
480
490
Clark Fork River Miles
81-84 # of Taxa
CI
Cu-CI

Figure 31

calculated for our data from those sites (Table 14). This comparison shows that as the contamination indices increase, taxa richness decreases (Figure 30). A similar comparison to benthic insect communities collected by Canton and Chadwick (1985) in 1981-1984 show similar relationships (Figure 31): as CI increases, the number of taxa decreases. These two independent comparisons are significant because they show the same relationships even though the benthic insect work was conducted several years apart and by different researchers. Such agreement supports the value of using CI as an indicator of the deleterious effects of sediment contamination on the biota of the Clark Fork River.

Table 14
Comparison of TI_{50} with Aquatic Macroinvertebrate Taxa Richness[1]

McGuire Site #	Our Site #	CF River Miles	CI	Cu-CI	Number of Taxa 1986	Number of Taxa 1987	Number of Taxa 1988
13	CF-1	371	1.0	0.9	34	36	44
12	CF-6	387	1.4	1.3	28	36	34
11	CF-20	434	1.7	1.9	29	32	37
10	CF-16	447	2.1	2.6	26	27	29
9	CF-25	462	2.9	3.9	25	30	29
8	CF-26	475	2.9	3.8	22	23	30
7	CF-50	482	2.8	3.1	26	26	25
3	SB-1	489	8.0	9.7	8	12	14
2	SB-3	500	17.4	26.9	8	9	13

[1] Clark Fork taxa richness data from D.L. McGuire, 1990.

Downstream trends in contamination indices also reflect trends in metal concentrations found in benthic insect taxa by Axtmann, Cain and Luoma (1990). These researchers show that at least six taxa of benthic insects have metals elevated over tributary insects. They also find that the trend in insect metal concentrations is similar to downstream trends in sediment metals, albeit more complex. Recent research by Boggs (personal communication, 1992) also found a decrease in metal concentration in the tissue of two genera of aquatic macro invertebrates corresponding to downstream decreases in concentrations of those metals in sediments collected at the same locations and times. Coupling this research with the present work, provides strong evidence of sediment contamination causing injury to aquatic life in the Clark Fork River and Silver Bow Creek.

Comparisons of Fisheries 'State' Pairs

For the purpose of fisheries population work Don Chapman Consultants (1992) considered the Clark Fork River and Silver Bow Creek to be "test" streams and the remaining seven streams to be "reference" streams. Each stream was divided into reaches based on a hierarchal classification which includes ecological, geological, geomorphic, and hydrologic characteristics. Within each reach, smaller segments called "states" were categorized on the basis of channel and bank characteristics into one of eleven types.[7] In order to control for the variables incorporated in stream reach classification and state types; they matched sites in test streams with similar state-reach sites in reference streams for measuring fish population measurements. Eighteen of these state type pairs were employed by Don Chapman Consultants (1992) to test the hypothesis of no difference in fish populations between test and reference streams.

We compare our sediment sampling sites to corresponding fisheries state types used in fish population comparisons. Each test or reference half of the 18 pairs is represented by at least one sediment sampling site, the number of sites sampled for sediment chemistry in each state ranged up to eight (Table 15). Where more than one sediment sample exists for a test, or reference, half of a stream state pair the chemical data are averaged. Thus each test and reference stream in each of the eighteen state pairs is represented by a single concentration for each contaminant.

---

[7] However, not all eleven types were identified in the streams studied.

The data are then analyzed graphically and statistically in a like manner to the fish population work. Both Wilcoxon signed-rank and 1-tailed paired T-Test[8] are used to statistically test the difference between the test and reference stream state pairs. For the 'test' streams (Clark Fork & Silver Bow Creek) pair numbers progress upstream so that in figures 32-36 upstream is to the right. The results (Figures 32-36) show a dramatic and highly significant elevation in sediment contaminant concentrations in the test streams, results which match very well with the depression in fish numbers and biomass found by Don Chapman Consultants (1992).

The difference in contaminant concentration between the test and reference streams can be summarized as a single number for a given contaminant by the mean test/reference ratio of metal concentration in these eighteen pairs. These ratios were calculated for As, Cd, Cu, Fe, Mn, Pb, and Zn, and are presented as mean sediment metal elevation in test streams for the eighteen state pairs (Figure 37). A value of one for the test/reference ratio (the horizontal line near bottom of graph) represents equal mean concentrations for test and reference streams in the eighteen state pairs compared. The degree of elevation in the test streams for these seven metals is quite apparent. Cadmium and copper are the most prominent contaminants with greater than 70-fold elevation in sediment from the Clark Fork River and Silver Bow Creek (test streams) versus reference streams. Although the test streams are almost equally, and extremely, elevated in cadmium and copper, the contamination index discussed in the previous section indicates that this level of elevation is not as important toxicologically for cadmium as it is for copper (see Figures 27 & 29).

---

[8] The null hyptohesis is that reference streams will have contaminant concentrations equal to test streams (H_0: T-R=0), the alternate hypothesis is that test streams will have greater contaminant concentrations (H_A: T-R>0).

Although stream state pairs 12 and 14, which compare reference states in Flint Creek to test states in the Clark Fork River, show little difference for As and Pb (Figures 32 and 35), they show a marked difference in Cu (Figure 34)—and in fish populations (Chapman Consultants; 1992). In light of the above toxicological considerations, similar As or Pb concentrations in a test reference stream are not necessarily contradictory to differences seen in fish populations. Because copper is typically more toxic than either arsenic or lead in aquatic systems, and since Flint Creek is not substantially contaminated with copper, the seemingly anomalously high fisheries populations in Flint Creek can be explained by the low copper enrichment there.

Table 15
Matching of Sediment Sampling Sites with State Types in Test and Reference Streams

Pair #	Test Stream				Reference Stream			
	Stream	Reach	State Type	Sediment Sampling Sites	Stream	Reach	State Type	Sediment Sampling Sites
1	CF	1	7/3	55	RC	1	3	1,3
2	CF	1	4/5	1	RC	1	3	1,3
3	CF	1	3/5	2,3,4,33,34	RC	1	3	1,3
4	CF	2	3	6	RC	1	3	1,3
5	CF	2	4	5,7,8,9,10,31,32,54	RC	1	10	5,6
6	CF	2	2	13	RC	1	2	2,4
7	CF	3	4	11,14,35	BH	5	11	1,7
8	CF	3	3	15	BH	5	3	2
9	CF	4	3	12,21,22,37	BH	5	3/10	3,8,9
10	CF	4	4	20,38	BH	5	10	1,7
11	CF	5	4	17,18,19,40,41,42, 43,53	BH	4	10	4,10,11
12	CF	6	2d	27,48,51	FC	1	2	1,2,3
13	CF	6	4	52	RR	1	4	1
14	CF	6	2u	26,49	FC	1	2	1,2,3
15	SB	7	2	1	RR	3	2	2,5,6
16	SB	7	4/6	2,5	BH	1	3/9	5,6,12
17	SB	9	4/6	3,10,11	BC	1	3/2	1,2,3
18	SB	10	3/6	4,6,7	BC	3	3/2	4,5,6

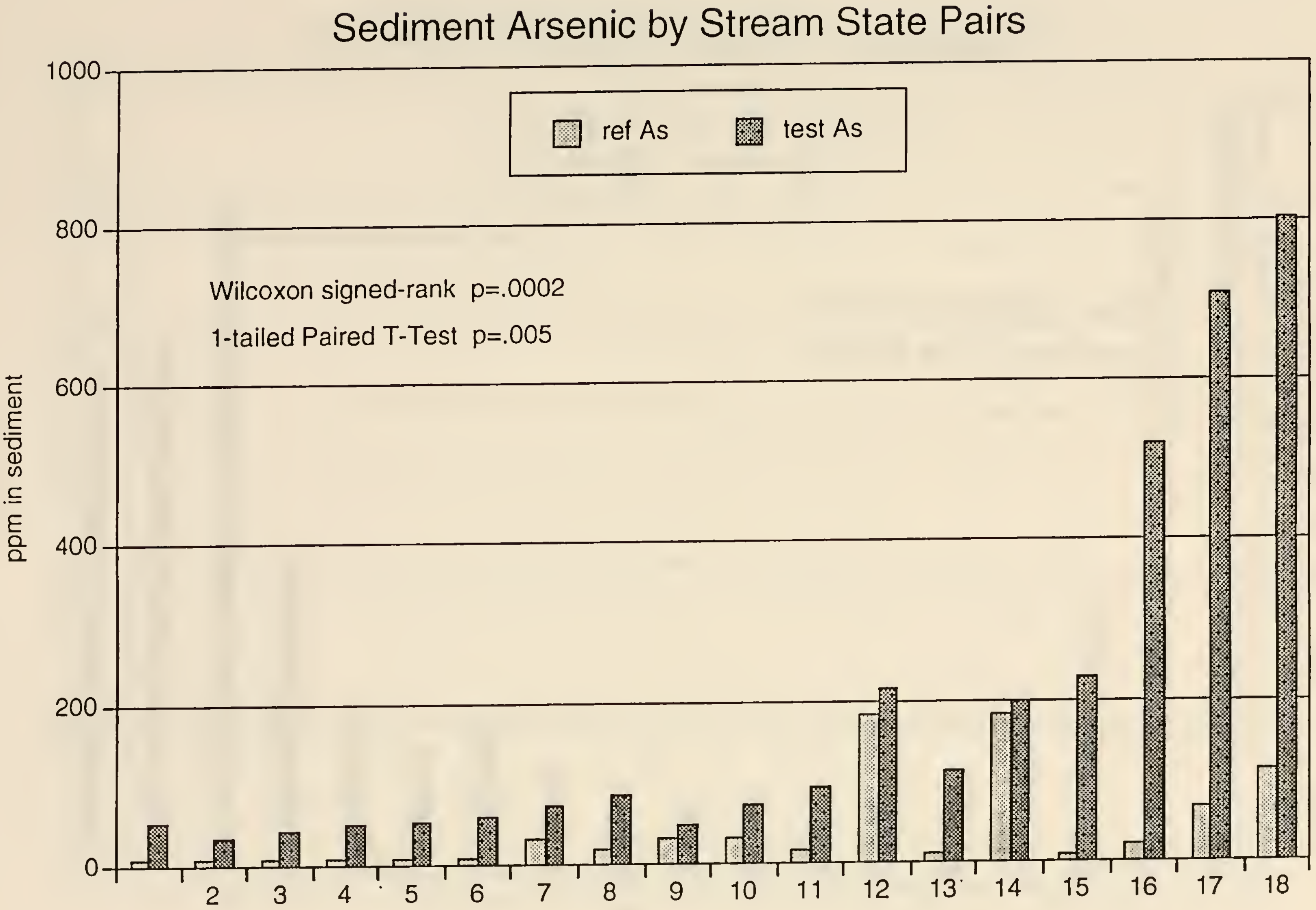

Sediment Arsenic by Stream State Pairs
ref As
test As
Wilcoxon signed-rank p=.0002
1-tailed Paired T-Test p=.005
ppm in sediment
1000
800
600
400
200
0
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Figure 32

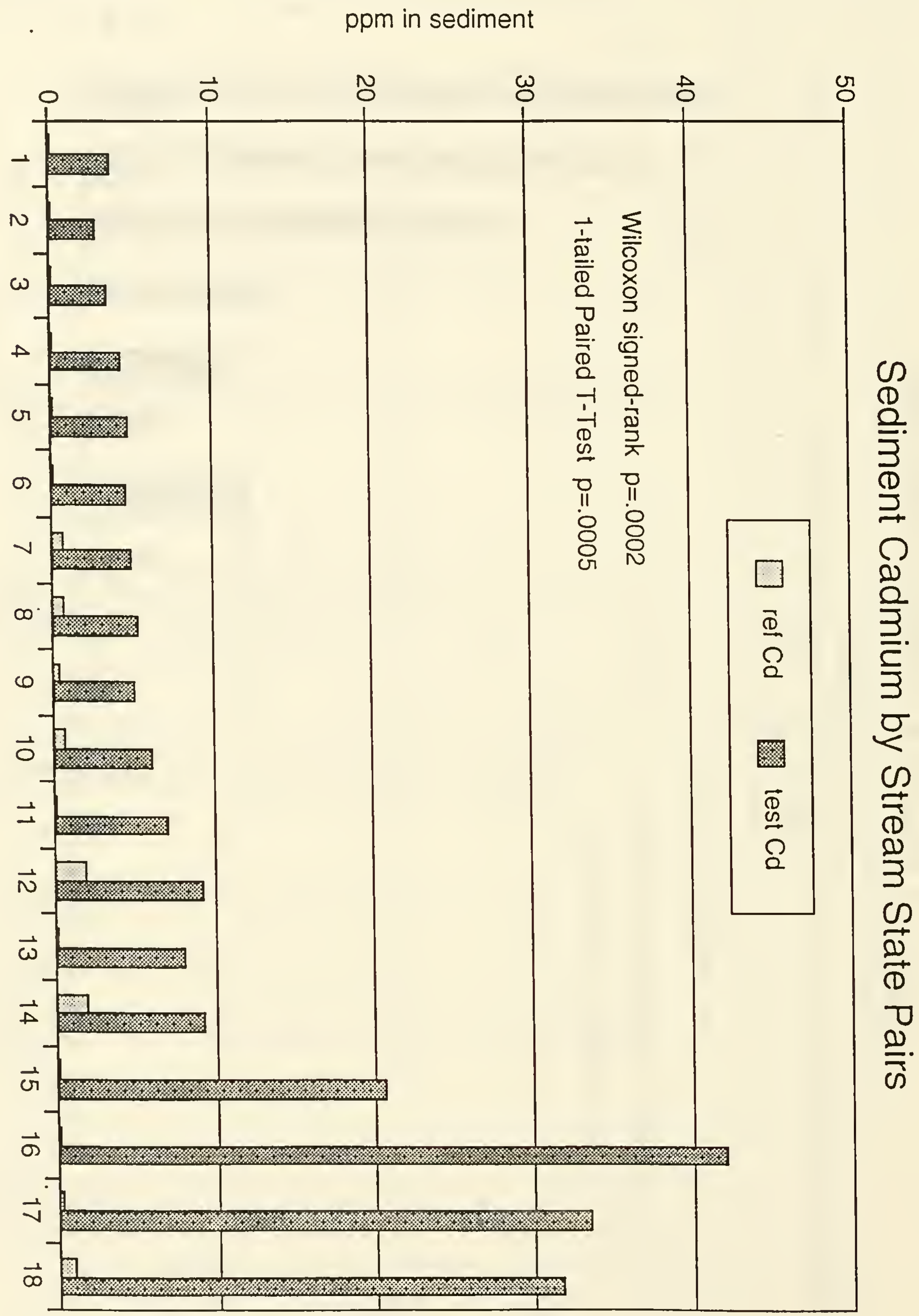
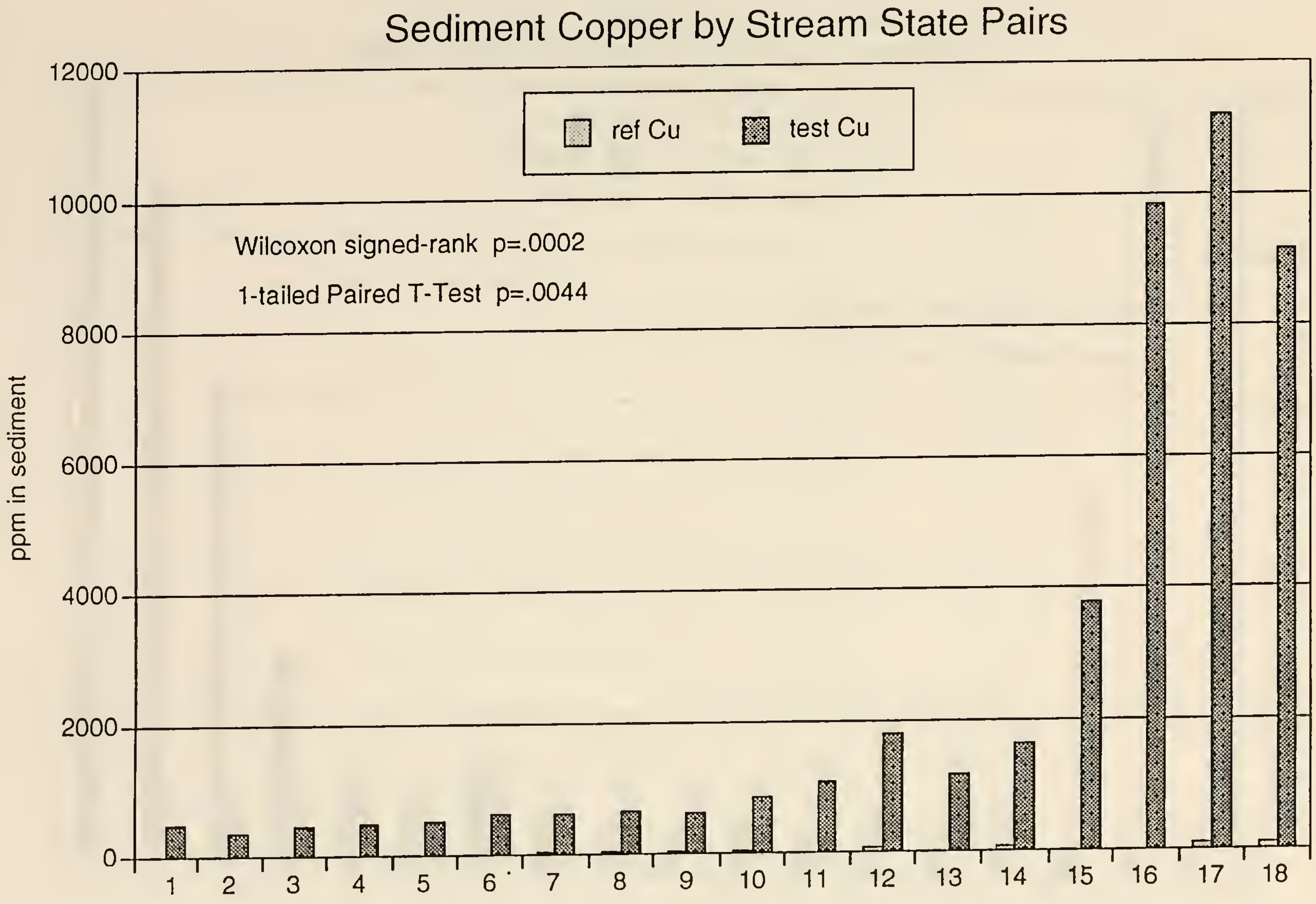

Sediment Cadmium by Stream State Pairs
ppm in sediment
0
10
20
30
40
50
▨ ref Cd
▨ test Cd
Wilcoxon signed-rank p=.0002
1-tailed Paired T-Test p=.0005
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Figure 33



Sediment Copper by Stream State Pairs

Figure 34

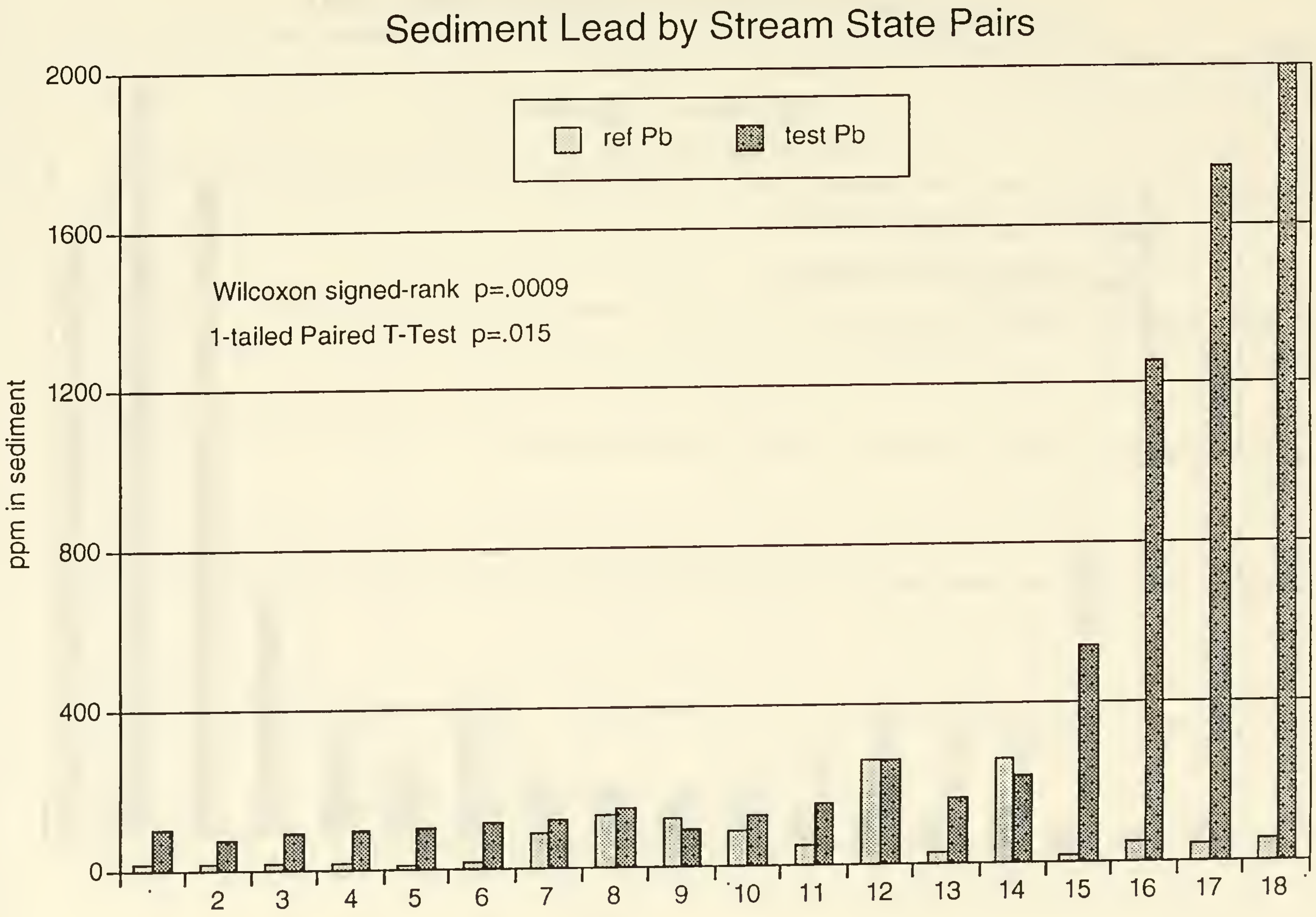

Sediment Lead by Stream State Pairs
ref Pb
test Pb
Wilcoxon signed-rank p=.0009
1-tailed Paired T-Test p=.015
ppm in sediment
2000
1600
1200
800
400
0
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Figure 35

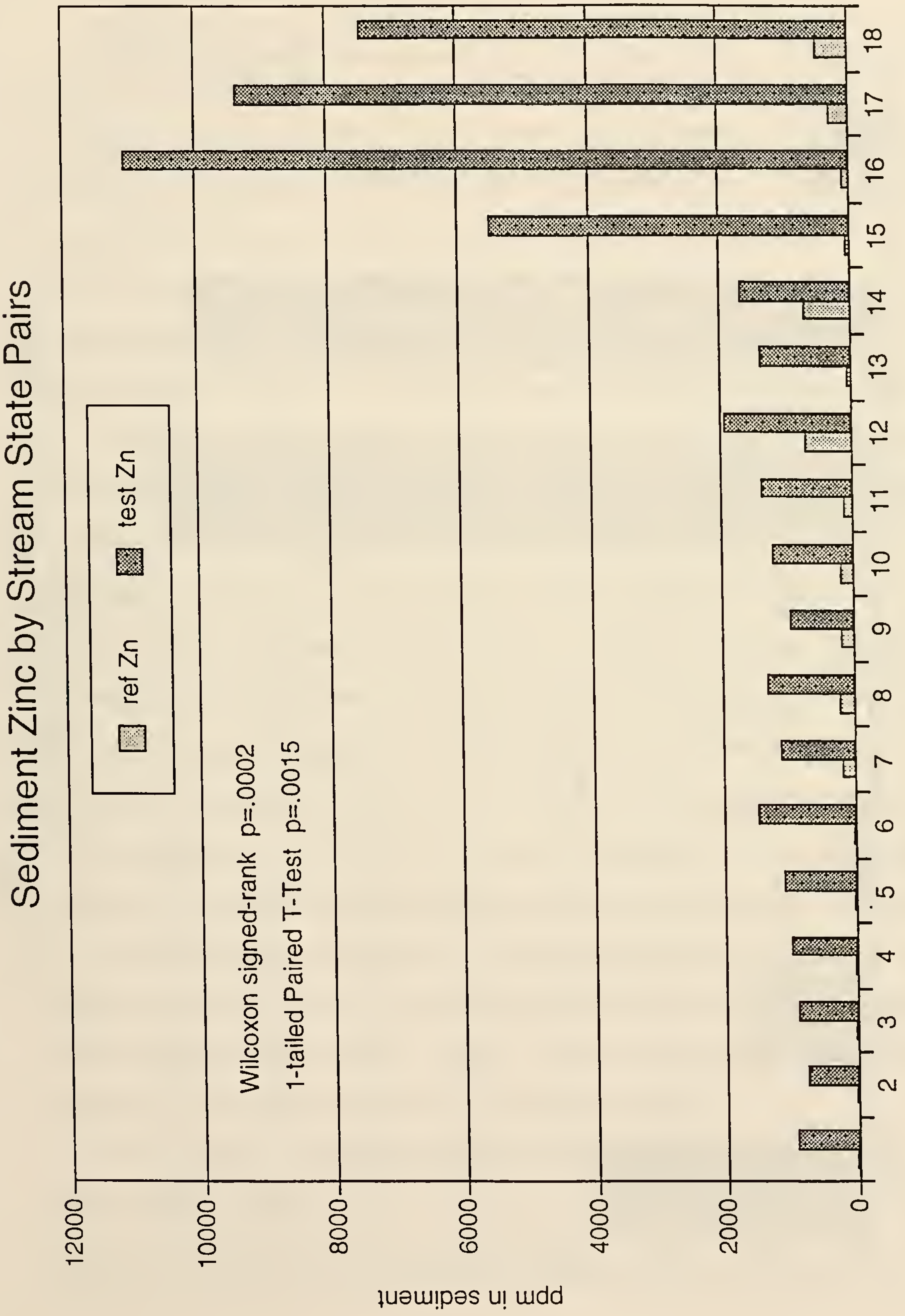

Sediment Zinc by Stream State Pairs
ref Zn
test Zn
Wilcoxon signed-rank p=.0002
1-tailed Paired T-Test p=.0015
ppm in sediment
12000
10000
8000
6000
4000
2000
0
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

Figure 36

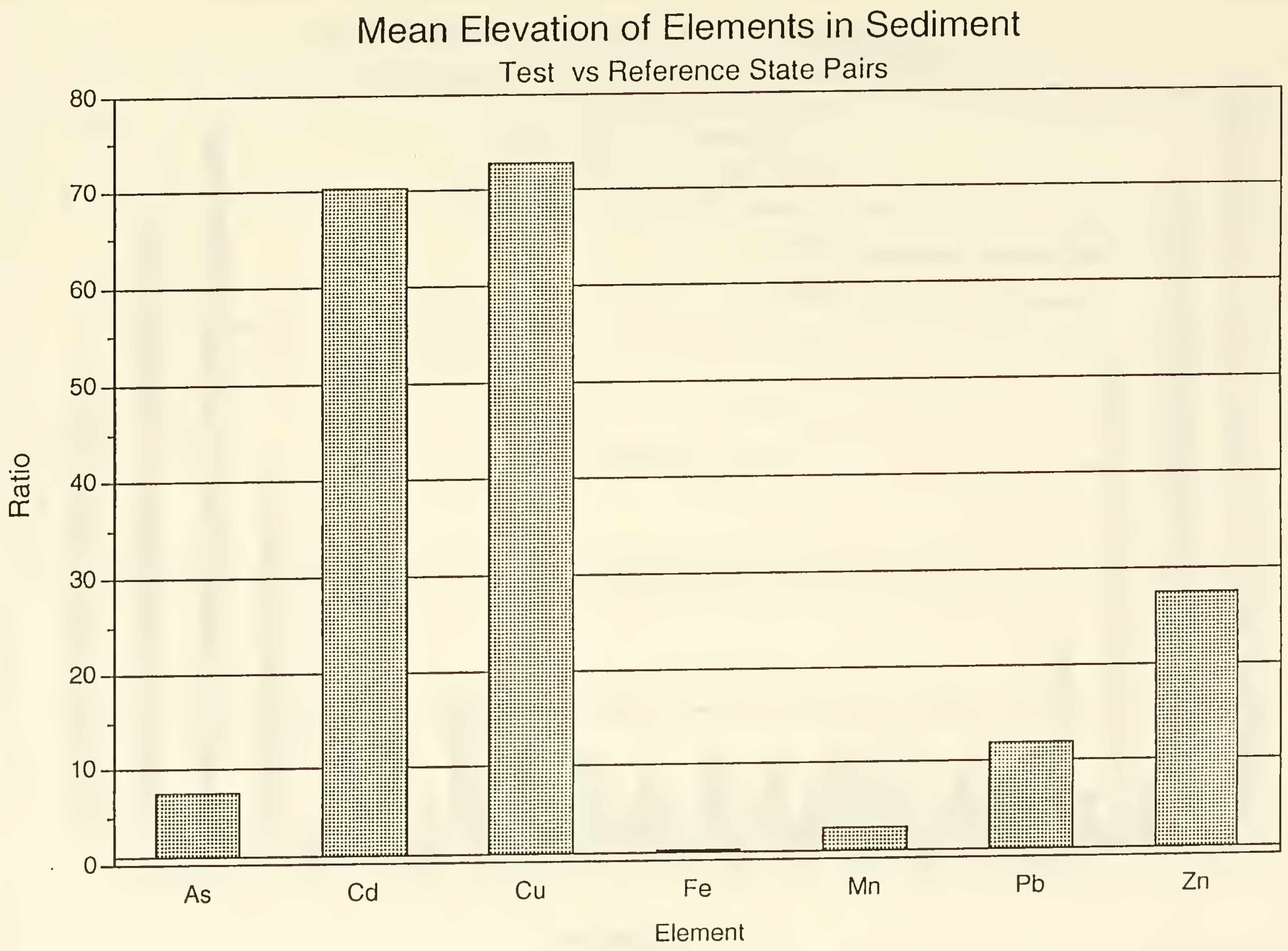

Mean Elevation of Elements in Sediment
Test vs Reference State Pairs
Ratio
80
70
60
50
40
30
20
10
0
As
Cd
Cu
Fe
Mn
Pb
Zn
Element

Figure 37

CONCLUSIONS

We have found that the fine bed sediments of the Clark Fork River are highly contaminated with arsenic, cadmium, copper, lead, and zinc. These contaminants show a decreasing downstream trend in sediment concentrations that is strongly indicative of dilution from an upstream source. Both findings are consistent with earlier work (Brook and Moore, 1988; Axtmann and Luoma, 1991). Our work has further shown that this contamination continues with increasing severity into the Silver Bow Creek drainage, the site of historic disposal of mine tailings from mineral extraction in and around Butte Montana.

Our use of elemental ratios to characterize sources rules out Flint Creek (or other tributaries) as a significant source of Clark Fork River contamination. Elemental ratios of contaminants, basin–wide trends, and magnitude of contamination all point to an upstream source of contaminants, where mining, milling, and air-fall deposits provide sources of sufficient size and chemistry to account for Clark Fork River metals contamination (Moore and Luoma, 1990). The most severe contamination is due to copper, but contamination by cadmium, zinc, arsenic, and lead also occurs. Despite cleanup efforts, changes in disposal practices, and a reduction in scale of operations, effects persist today from historic mining, ore concentration, and the attendant disposal of tailings. Sediment concentrations of arsenic, cadmium, copper, lead, and zinc are significantly elevated above baseline throughout the Clark Fork River from Butte to Missoula; copper concentrations remain at least fifteen times above baseline at a distance of 150 river miles below the upstream sources.

Comparison of our sediment analyses to the work of Long and Morgan (1991) on sediment toxicity show that Clark Fork River and Silver Bow Creek sediment concentrations of the five contaminants, arsenic, cadmium, copper, lead, and zinc, exceed (in most case by many times) their thresholds for probable biological effect. A contamination index based on Long and Morgan thresholds shows an inverse relationship with taxa richness in the Clark Fork River reported by McGuire (1990) and Canton and Chadwick (1985). The contamination index reveals that copper concentrations in the upper segment of the Clark Fork River are three times, and in Silver Bow Creek nearly twenty-four times, the level of probable biological effect.

Sediment analytical results from fisheries study sites in the Clark Fork River-Silver Bow Creek and reference streams show that metals concentrations are elevated in the test streams as much as seventy-fold (cadmium and copper). However, from a toxicological standpoint it is likely this degree of elevation is far more important for copper. The primary source of copper contamination is the past and present mining/processing of copper ores at Butte, Montana. Fisheries population work conducted by Don Chapman Consultants (1992) mirror the results of sediment metals work: contaminant metals are elevated in the test streams, and fish populations are diminished or absent. Sediment toxicity resulting from copper contamination best explains these differences in fish population.

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Appendix A

Sampling Information

Sediment Digest Sample List
Sample Location by U.S.G.S. Quadrangle
Locality Map
U.S.G.S. Quadrangles (1:24,000)

CFDA Sediment Digests - Sample List

Lab ID #	Field ID #		upstream order	CF River Miles	Reach #
CFDA 1	BC-01				
CFDA 2	BC-02-X				
CFDA 3	BC-02-Y				
CFDA 4	BC-02-Z				
CFDA 5	BC-03				
CFDA 6	BC-04				
CFDA 7	BC-05-X				
CFDA 8	BC-05-Y				
CFDA 9	BC-05-Z				
CFDA 10	BC-06-A				
CFDA 11	BC-06-B				
CFDA 12	BH-01				
CFDA 13	BH-01-Y				
CFDA 14	BH-01-Z				
CFDA 15	BH-02				
CFDA 16	BC-03	d			
CFDA 17	BH-04-X				
CFDA 18	BH-03				
CFDA 19	BC-05-X	s			
CFDA 20	USGS SED2				
CFDA 21	Blank				
CFDA 22	BH-04-Y				
CFDA 23	BH-04-Z				
CFDA 24	BH-05				
CFDA 25	BH-05-Y				
CFDA 26	BH-05-Z				
CFDA 27	BH-06				
CFDA 28	BH-07				
CFDA 29	BH-08-A				
CFDA 30	BH-08-B				
CFDA 31	BH-09				
CFDA 32	BH-10				
CFDA 33	BH-11				
CFDA 34	BH-12				
CFDA 35	FC-01-X			417.6	
CFDA 36	FC-01-Y			417.6	
CFDA 37	FC-01-Z			417.6	
CFDA 38	FC-02			417.6	
CFDA 39	Blank				
CFDA 40	BH-01	d			
CFDA 41	BH-04-Y	s			
CFDA 42	USGS SED2				

d	denotes duplicate digest
s	denotes spiked digest
-X,Y,Z	denotes field replicates
-A,B	denotes field splits

Stream Key

BC = Bison Creek
BH = Big Hole
CF = Clark Fork
FC = Flint Creek
GC = Gold Creek
LB = Little Blackfoot
RC = Rock Creek
RR = Ruby River
SB = Silver Bow Creek

DUPLICATE SAMPLES		(d)
5	BC-03	d
12	BH-01	d
116	GC-02-Z	d
147	RR-09	d
31	CF-01-X	d
35	CF-03-A	d
46	CF-11	d
78	CF-36	d
154	SB-03-Y	d
170	SB-13-B	d

SPIKE SAMPLES		(s)
7	BC-05-X	s
18	BH-04-Y	s
24	BH-07	s
25	BH-08-A	s
122	LB-03	s
145	RR-07	s
77	CF-35	s
62	CF-22-X	s
85	CF-43	s
72	CF-30	s

CFDA Sediment Digests - Sample List

Lab ID #	Field ID #		upstream order	CF River Miles	Reach #
CFDA 43	FC-03			417.6	
CFDA 44	FC-03-Y			417.6	
CFDA 45	FC-03-Z			417.6	
CFDA 46	GC-01			435.8	
CFDA 47	GC-02-X			435.8	
CFDA 48	GC-02-Y			435.8	
CFDA 49	GC-02-Z			435.8	
CFDA 50	GC-03			435.8	
CFDA 51	LB-01			445.7	
CFDA 52	LB-02-X			445.7	
CFDA 53	LB-02-Y			445.7	
CFDA 54	LB-02-Z			445.7	
CFDA 55	LB-03			445.7	
CFDA 56	RC-01			381.8	
CFDA 57	RC-01-Y			381.8	
CFDA 58	RC-01-Z			381.8	
CFDA 59	Blank				
CFDA 60	RC-02			381.8	
CFDA 61	GC-02-Z	d		435.8	
CFDA 62	BH-07	s			
CFDA 63	USGS SED2				
CFDA 64	RC-02-Y			381.8	
CFDA 65	RC-02-Z			381.8	
CFDA 66	RC-03			381.8	
CFDA 67	RC-03-Y			381.8	
CFDA 68	RC-03-Z			381.8	
CFDA 69	RC-04			381.8	
CFDA 70	RC-05			381.8	
CFDA 71	RC-06			381.8	
CFDA 72	RR-01				
CFDA 73	RR-02				
CFDA 74	RR-03				
CFDA 75	RR-04-X				
CFDA 76	RR-04-Y				
CFDA 77	RR-04-Z				
CFDA 78	RR-05-X				
CFDA 79	Blank				
CFDA 80	RR-05-Y				
CFDA 81	RR-05-Z				
CFDA 82	RR-09	d			
CFDA 83	BH-08-A	s			
CFDA 84	USGS SED2				

CFDA Sediment Digests - Sample List

Lab ID #	Field ID #		upstream order	CF River Miles	Reach #
CFDA 85	RR-06				
CFDA 86	RR-07				
CFDA 87	RR-08				
CFDA 88	RR-09				
CFDA 89	RR-10				
CFDA 90	CF-55-A		55	367.6	1
CFDA 91	CF-55-B		55	367.6	1
CFDA 92	CF-01-X		54	370.6	1
CFDA 93	CF-01-Y		54	370.6	1
CFDA 94	CF-01-Z		54	370.6	1
CFDA 95	CF-02		53	372.2	1
CFDA 96	CF-03-A		52	378.9	1
CFDA 97	CF-03-B		52	378.9	1
CFDA 98	CF-34		51	381.2	1
CFDA 99	Blank				
CFDA 100	CF-04		50	381.6	1
CFDA 101	CF-33		49	381.7	1
CFDA 102	CF-32		48	381.9	2
CFDA 103	CF-01-X	d	54	370.6	1
CFDA 104	LB-03	s		445.7	
CFDA 105	USGS SED2				
CFDA 106	CF-31		47	382.1	2
CFDA 107	CF-05		46	382.2	2
CFDA 108	CF-06		45	387.1	2
CFDA 109	CF-06-Y		45	387.1	2
CFDA 110	CF-06-Z		45	387.1	2
CFDA 111	CF-07		44	391.4	2
CFDA 112	CF-54		43	395.9	2
CFDA 113	CF-08		42	398	2
CFDA 114	CF-09		41	402.9	2
CFDA 115	CF-10		40	408.8	2
CFDA 116	CF-13-X		39	409.6	2
CFDA 117	CF-13-Y		39	409.6	2
CFDA 118	Blank				
CFDA 119	CF-13-Z		39	409.6	2
CFDA 120	CF-14		38	415.5	3
CFDA 121	CF-11		37	416.4	3
CFDA 122	CF-35		36	416.8	3
CFDA 123	CF-15		35	417.2	3
CFDA 124	CF-03-A	d	52	378.9	1
CFDA 125	RR-07	s			
CFDA 126	USGS SED2				

CFDA Sediment Digests - Sample List

Lab ID #	Field ID #		upstream order	CF River Miles	Reach #
CFDA 127	CF-15-Y		35	417.2	3
CFDA 128	CF-15-Z		35	417.2	3
CFDA 129	CF-36		34	417.65	3
CFDA 130	CF-37		33	418	4
CFDA 131	CF-12		32	418.5	4
CFDA 132	CF-21		31	424.6	4
CFDA 133	CF-22-X		30	429.3	4
CFDA 134	CF-22-Y		30	429.3	4
CFDA 135	CF-22-Z		30	429.3	4
CFDA 136	CF-53		29	431.7	4
CFDA 137	Blank				
CFDA 138	CF-20		28	434.3	4
CFDA 139	CF-38		27	435.6	4
CFDA 140	CF-39		26	435.8	4
CFDA 141	CF-40		25	435.9	5
CFDA 142	CF-41		24	436.2	5
CFDA 143	CF-19		23	436.4	5
CFDA 144	CF-18-A		22	438.7	5
CFDA 145	CF-11	d	37	416.4	3
CFDA 146	CF-35	s	36	416.8	3
CFDA 147	USGS SED2				
CFDA 148	CF-18-B		22	438.7	5
CFDA 149	CF-52-X		21	442	5
CFDA 150	CF-52-Y		21	442	5
CFDA 151	CF-52-Z		21	442	5
CFDA 152	CF-17		20	444.5	5
CFDA 153	CF-42		19	444.8	5
CFDA 154	CF-43		18	445.2	5
CFDA 155	CF-44		17	445.8	6
CFDA 156	Blank				
CFDA 157	CF-45		16	446.2	6
CFDA 158	CF-16		15	447	6
CFDA 159	CF-46-A		14	451.4	6
CFDA 160	CF-46-B		14	451.4	6
CFDA 161	CF-23		13	453.8	6
CFDA 162	CF-24		12	456.5	6
CFDA 163	CF-47		11	460.4	6
CFDA 164	CF-25		10	461.8	6
CFDA 165	CF-51		9	465.6	6
CFDA 166	CF-36	d	34	417.65	3
CFDA 167	CF-22-X	s	30	429.3	4
CFDA 168	USGS SED2				

CFDA Sediment Digests - Sample List

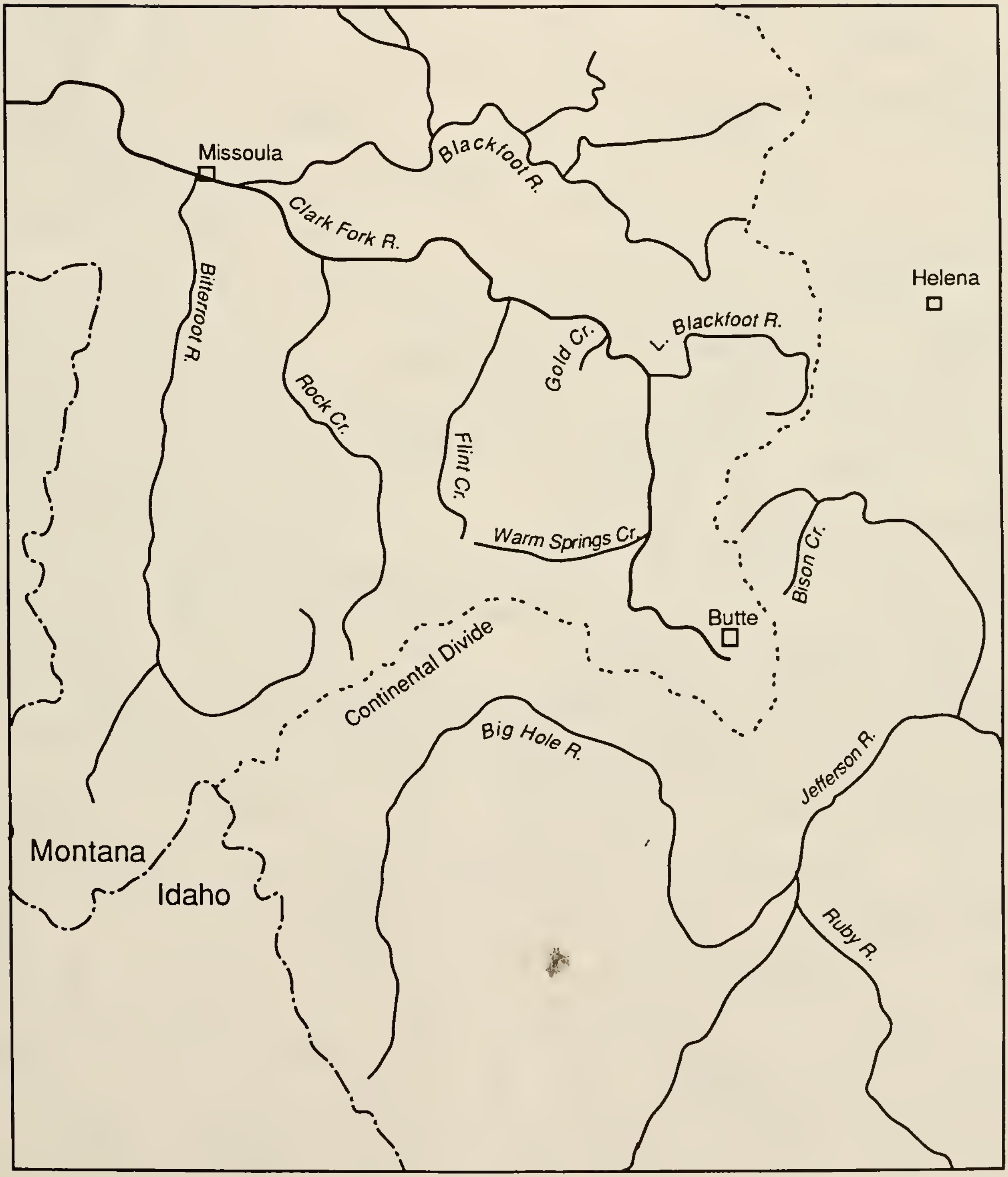
Lab ID #	Field ID #		upstream order	CF River Miles	Reach #
CFDA 169	CF-27		8	468.7	6
CFDA 170	CF-48A		7	470.4	6
CFDA 171	CF-48B		7	470.4	6
CFDA 172	CF-26		6	475.3	6
CFDA 173	CF-49-Y		5	477.2	6
CFDA 174	CF-49-Z		5	477.2	6
CFDA 175	Blank				
CFDA 176	CF-28		4	478.6	6
CFDA 177	CF-30		3	481.9	6
CFDA 178	CF-50-X		2	482.4	6
CFDA 179	CF-50-Y		2	482.4	6
CFDA 180	CF-50-Z		2	482.4	6
CFDA 181	CF-29		1	483.4	6
CFDA 182	SB-01		0	489	7
CFDA 183	SB-01-Y		0	489	7
CFDA 184	SB-01-Z		0	489	7
CFDA 185	SB-02-A		-3	494.5	7
CFDA 186	SB-02-B		-3	494.5	7
CFDA 187	SB-03-Y	d	-9	500	9
CFDA 188	CF-43	s	18	445.2	5
CFDA 189	USGS SED2				
CFDA 190	SB-03-X		-9	500	9
CFDA 191	SB-03-Y		-9	500	9
CFDA 192	SB-03-Z		-9	500	9
CFDA 193	SB-04		-11	504	10
CFDA 194	SB-05-Y		-4	495	7
CFDA 195	Blank				
CFDA 196	SB-05-Z		-4	495	7
CFDA 197	SB-06-X		-12	506.1	10
CFDA 198	SB-06-Y		-12	506.1	10
CFDA 199	SB-06-Z		-12	506.1	10
CFDA 200	SB-07		-10	502.3	10
CFDA 201	SB-08		-6	497.7	8
CFDA 202	SB-09		-5	497	8
CFDA 203	SB-10		-7	498.5	9
CFDA 204	SB-11		-8	499.3	9
CFDA 205	SB-12		-2	492.6	7
CFDA 206	SB-13-A		-1	491.6	7
CFDA 207	SB-13-B		-1	491.6	7
CFDA 208	SB-13-B	d	-1	491.6	7
CFDA 209	CF-30	s	3	481.9	6
CFDA 210	USGS SED2				

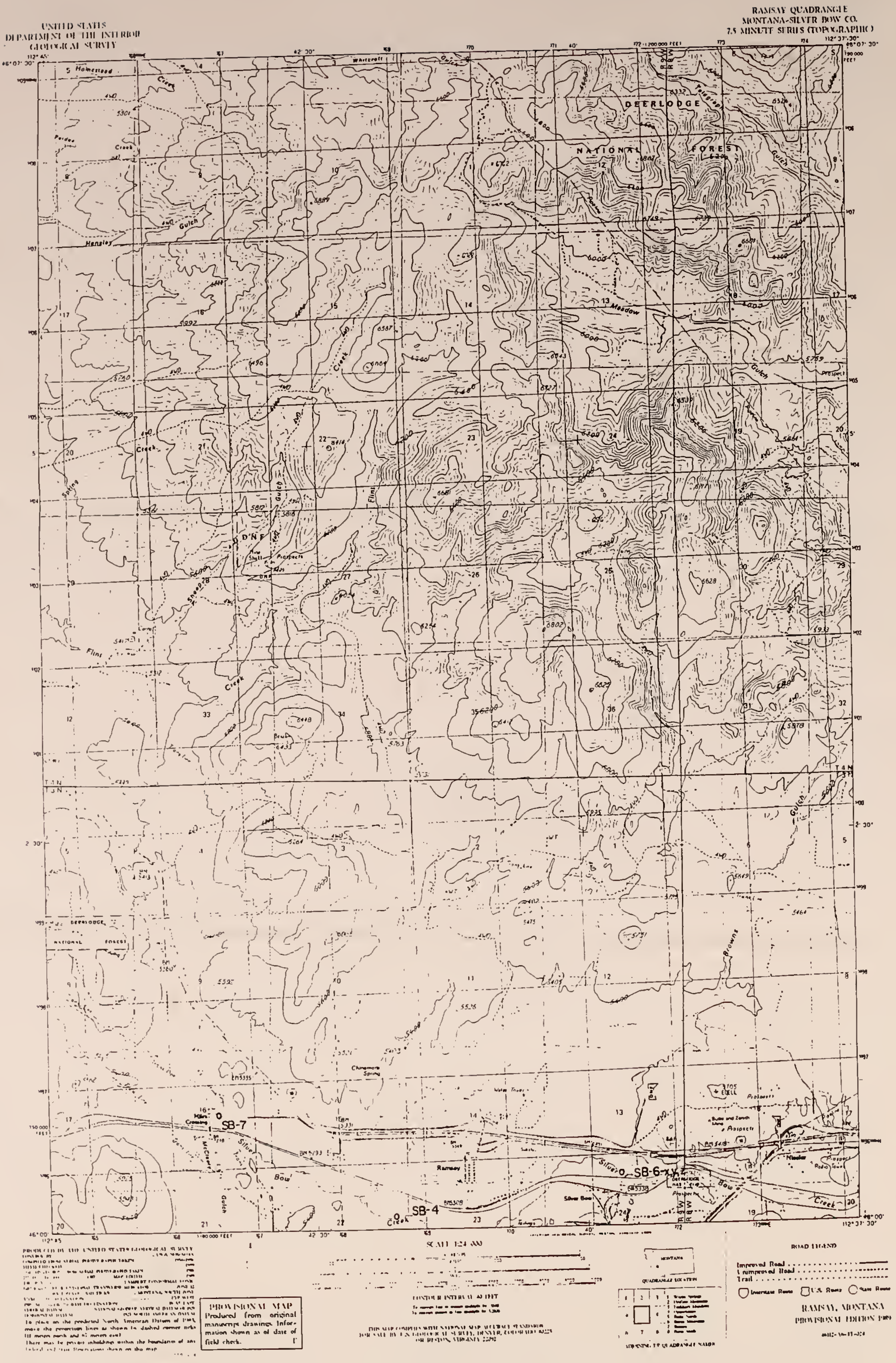
CFDA Sampling Locations by U.S.G.S. Quadrangles (1:24,000)

Quadrangle	Sample Label
Ramsey, MT.	SB-4 SB-6-x,y,z SB-7
Opportunity, MT	SB-2-A,B SB-3-x,y,z SB-5-y,z SB-8 SB-9 SB-10 SB-11 SB-12
Warm Springs, MT.	CF-28 CF-29 CF-30 CF-50-x,y,z SB-1 SB-1-y,z
Orofino Creek, MT.	CF-26 CF-27 CF-48-A,B CF-49-y,z CF-51
Deer Lodge, MT.	CF-23 CF-24 CF-25 CF-46-A,B CF-47
Garrison, MT.	CF-16 CF-17 CF-18-A,B CF-42 CF-43 CF-44 CF-45 CF-52-x,y,z
Griffin Creek, MT.	CF-19 CF-20 CF-38 CF-39 CF-40 CF-41 CF-53 GC-1
Griffin Creek (con't)	GC-2-x,y,z GC-3
Dunkleberg Creek	CF-21 CF-22-x,y,z
Drummond, MT.	CF-11 CF-12 CF-13-x,y,z CF-14 CF-15 CF-15-y,z CF-35 CF-36 CF-37 FC-1-x,y,z
Bearmouth, MT.	CF-9 CF-10
Medicine Tree Hill	CF-8 CF-54
Ravenna, MT	CF-6 CF-6-y,z CF-7
Iris Point, MT.	CF-4 CF-5 CF-31 CF-32 CF-33 CF-34 RC-1 RC-1-y,z RC-2 RC-2-y,z RC-3 RC-3-y,z RC-6
Clinton, MT.	CF-3
Bonner, MT.	CF-1-x,y,z CF-2 CF-55
Grizzly Point, MT.	RC-4 RC-5

Quadrangle	Sample Label
Hall, MT.	FC-2
	FC-3
	FC-3-y,z
Luke Mtn., MT.	LB-1
	LB-2-x,y,z
	LB-3
Elk Pass Park, MT.	BC-4
	BC-6-A,B
Bison Canyon, MT.	BC-1
	BC-2-x,y,z
	BC-3
	BC-5-x,y,z
Earls Gulch, MT.	BH-1
	BH-1-y,z
	BH-2
	BH-7
Glen, MT.	BH-3
	BH-8-A,B
	BH-9
Block Mtn., MT.	BH-4-x,y,z
	BH-10
	BH-11
Beaverhead Rock	BH-5
	BH-5-y,z
Twin Bridges SW	BH-12
Twin Bridges, MT.	BH-6
Metzel Ranch, MT.	RR-2
	RR-5-x,y,z
	RR-6
Sheridan, MT.	RR-4-x,y,z
	RR-3
Alder, MT.	RR-1
	RR-9
	RR-10

General Location Map
of
CFDA Study Area





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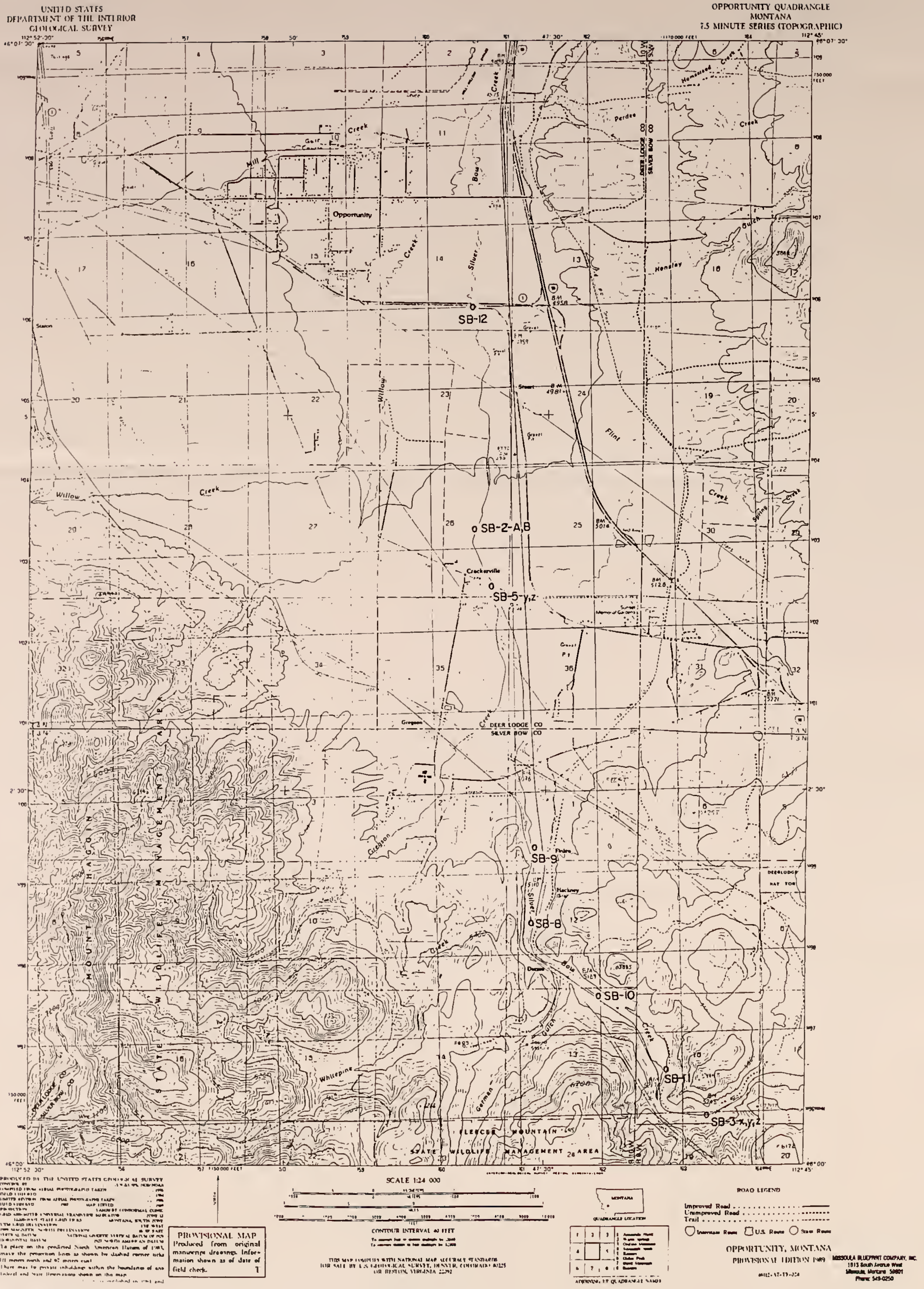
Phone 543-6250


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
OPPORTUNITY QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)
Opportunity
Mill
Creek
Golf Course
Silver
Bow
Creek
Perdee
Homestead
Henslay
Gulch
Willow
Creek
Flint
Creek
Spring
Crackerville
Sunset Memorial Gardens
Gravel Pit
Gregson
DEER LODGE CO
SILVER BOW CO
Fairmont
Hackney
Gregson
Whitepine
German
Gulch
Creek
MOUNT HAGGIN STATE WILDLIFE MANAGEMENT AREA
FLEECER MOUNTAIN STATE WILDLIFE MANAGEMENT AREA
T 4 N
T 3 N
SB-12
SB-2-A,B
SB-5-y,z
SB-9
SB-8
SB-10
SB-11
SB-3-x,y,z
SCALE 1:24 000
CONTOUR INTERVAL 40 FEET
PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225
OR RESTON, VIRGINIA 22092
MONTANA
QUADRANGLE LOCATION
ADJOINING 7.5' QUADRANGLE NAMES
ROAD LEGEND
Improved Road
Unimproved Road
Trail
Interstate Route
U.S. Route
State Route
OPPORTUNITY, MONTANA
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Missoula, Montana 59801
Phone 549-0250

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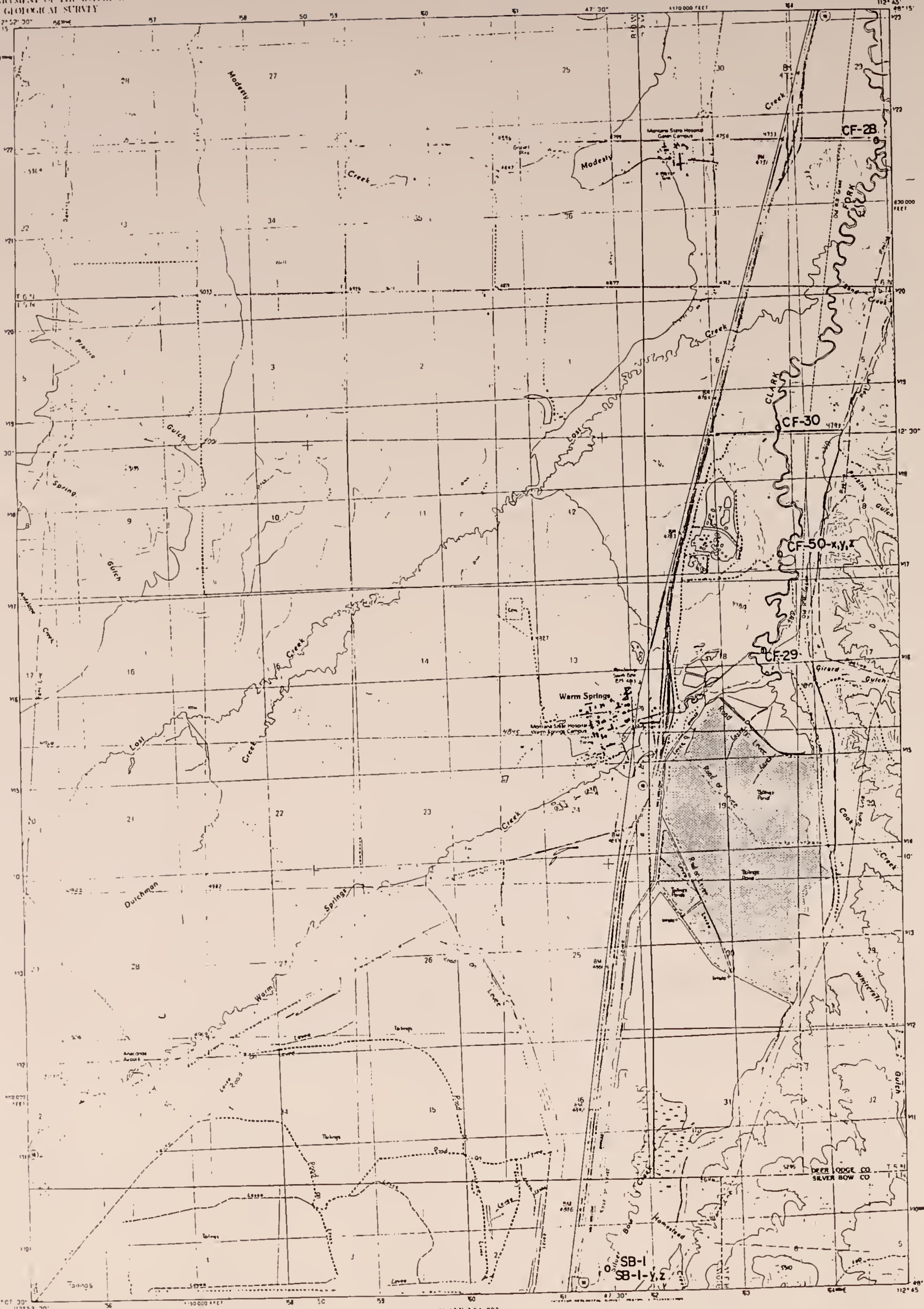
WARM SPRINGS QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24 000

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
[illegible]

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks [illegible]

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map.

Public Land Survey System is shown as published in 1981 and

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CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET

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MONTANA
QUADRANGLE LOCATION

ADJOINING 7.5′ QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail
Interstate Route
U.S. Route
State Route

WARM SPRINGS, MONTANA
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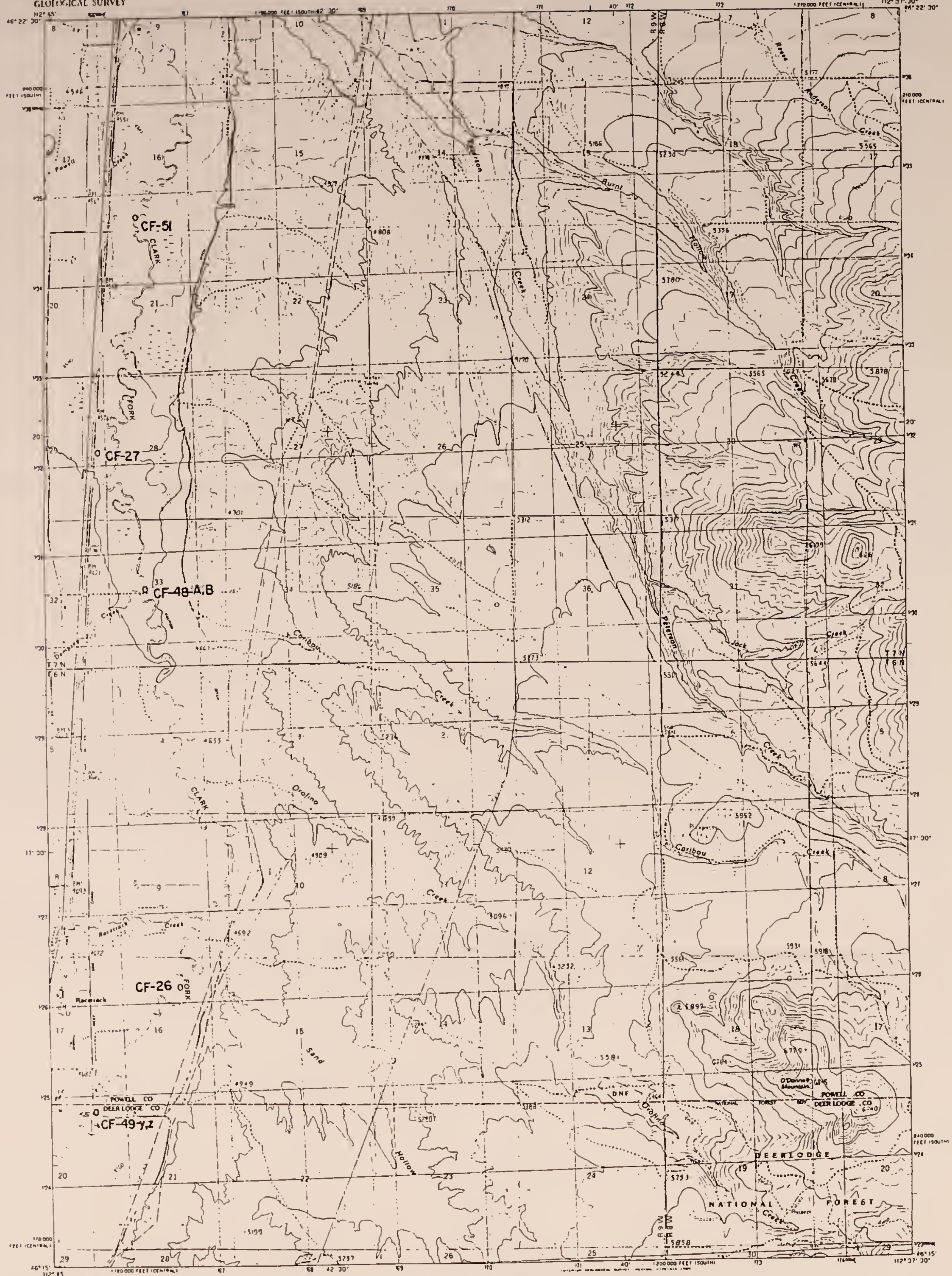
OROFINO CREEK QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



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[illegible]

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS

MONTANA

QUADRANGLE LOCATION

ROAD LEGEND

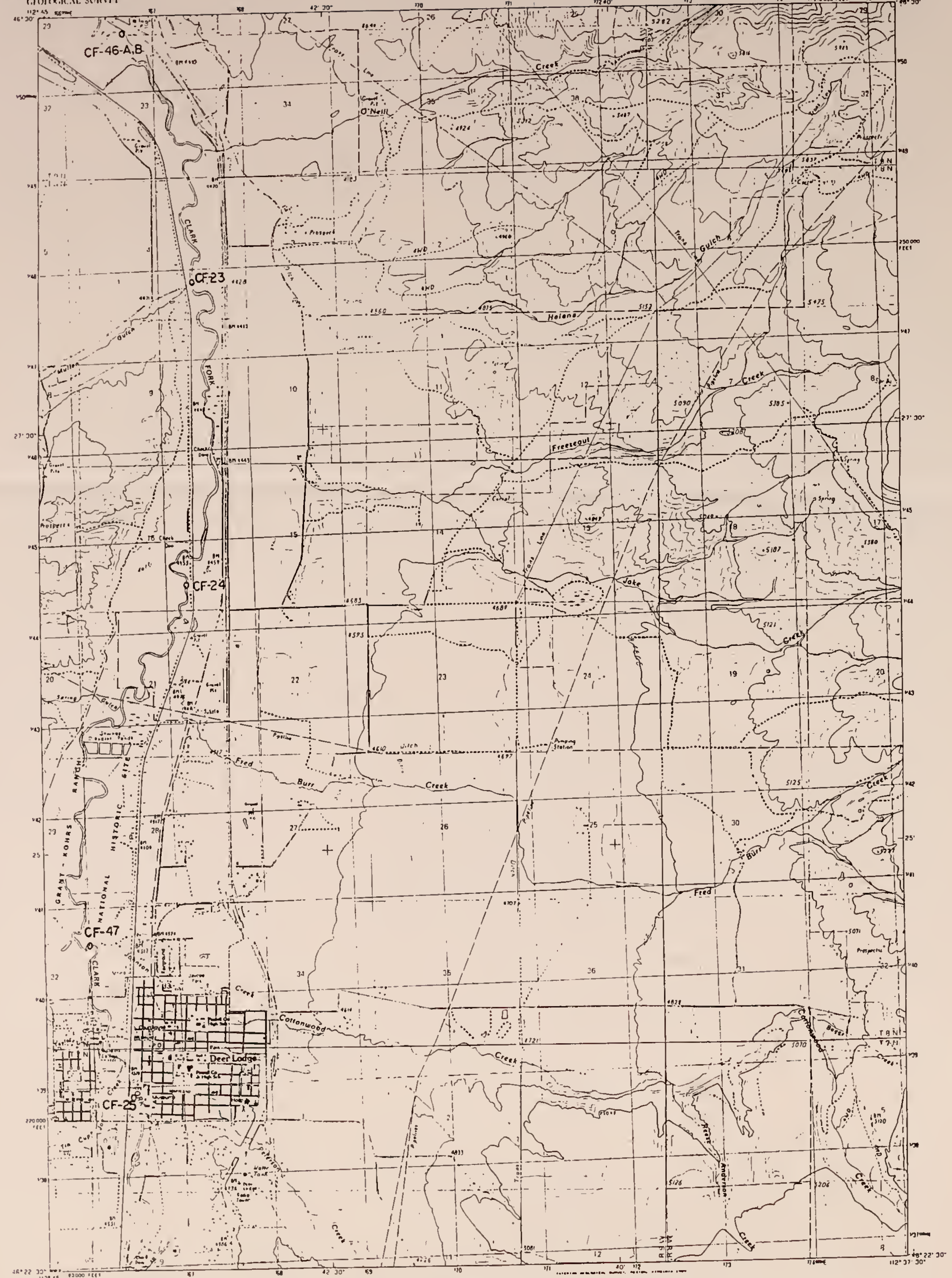
Improved Road
Unimproved Road
Trail

Interstate Route U.S. Route State Route

OROFINO CREEK, MONTANA
PROVISIONAL EDITION 1989

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

DEER LODGE QUADRANGLE
MONTANA-POWELL CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
[illegible]
LAMBERT CONFORMAL CONIC
MONTANA, CENTRAL ZONE
NATIONAL GEODETIC VERTICAL DATUM OF 1929
1927 NORTH AMERICAN DATUM
To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks (11 meters south and 62 meters east)
There may be private inholdings within the boundaries of any [illegible] on this map

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET

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OR RESTON, VIRGINIA 22092

MONTANA
QUADRANGLE LOCATION

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail

Interstate Route
U.S. Route
State Route

DEER LODGE, MONTANA
PROVISIONAL EDITION 1989

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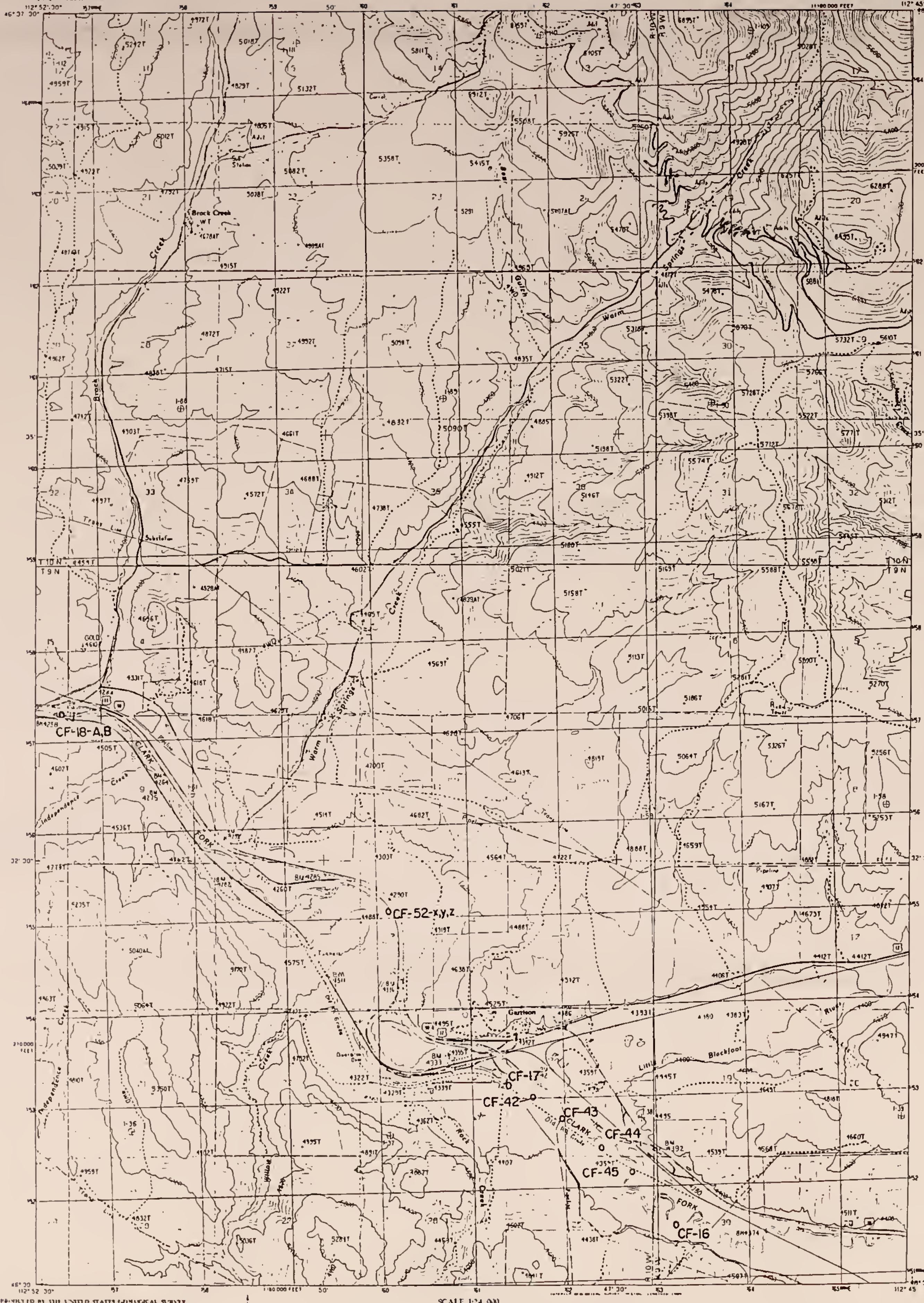
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GARRISON QUADRANGLE
MONTANA-POWELL CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks [illegible] meters north and [illegible] meters east

There may be private inholdings within the boundaries of any federal and state reservations shown on this map

No distinction made between houses, barns, and other buildings

PROVISIONAL MAP
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SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET

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OR RESTON, VIRGINIA 22092

MONTANA
QUADRANGLE LOCATION

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail

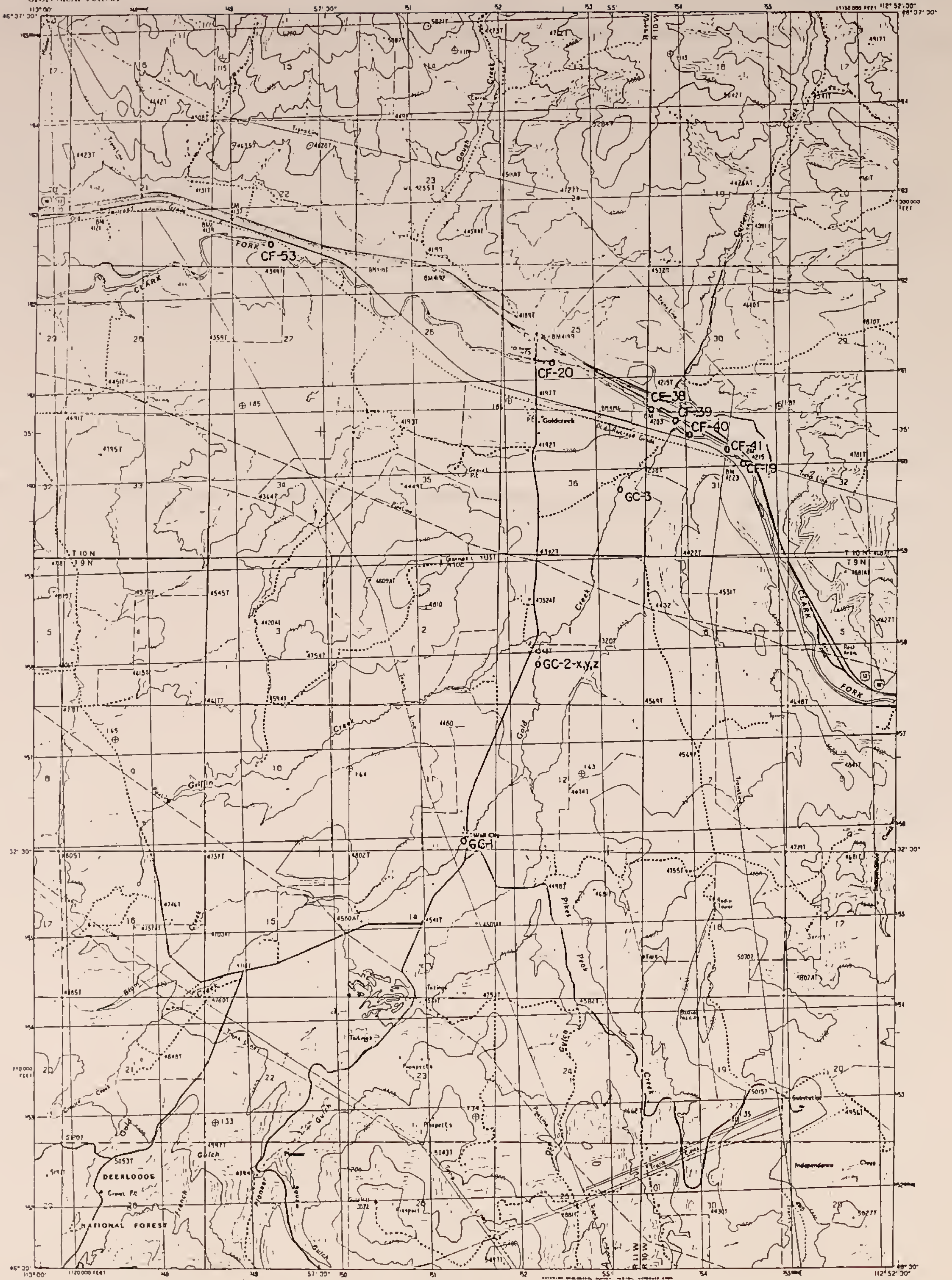
Interstate Route U.S. Route State Route

GARRISON, MONTANA
PROVISIONAL EDITION 1989

46112-E7-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GRIFFIN CREEK QUADRANGLE
MONTANA-POWELL CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



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PROVISIONAL MAP
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SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET

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OR RESTON, VIRGINIA 22092

MONTANA
QUADRANGLE LOCATION

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail
Interstate Route
U.S. Route
State Route

GRIFFIN CREEK, MONTANA
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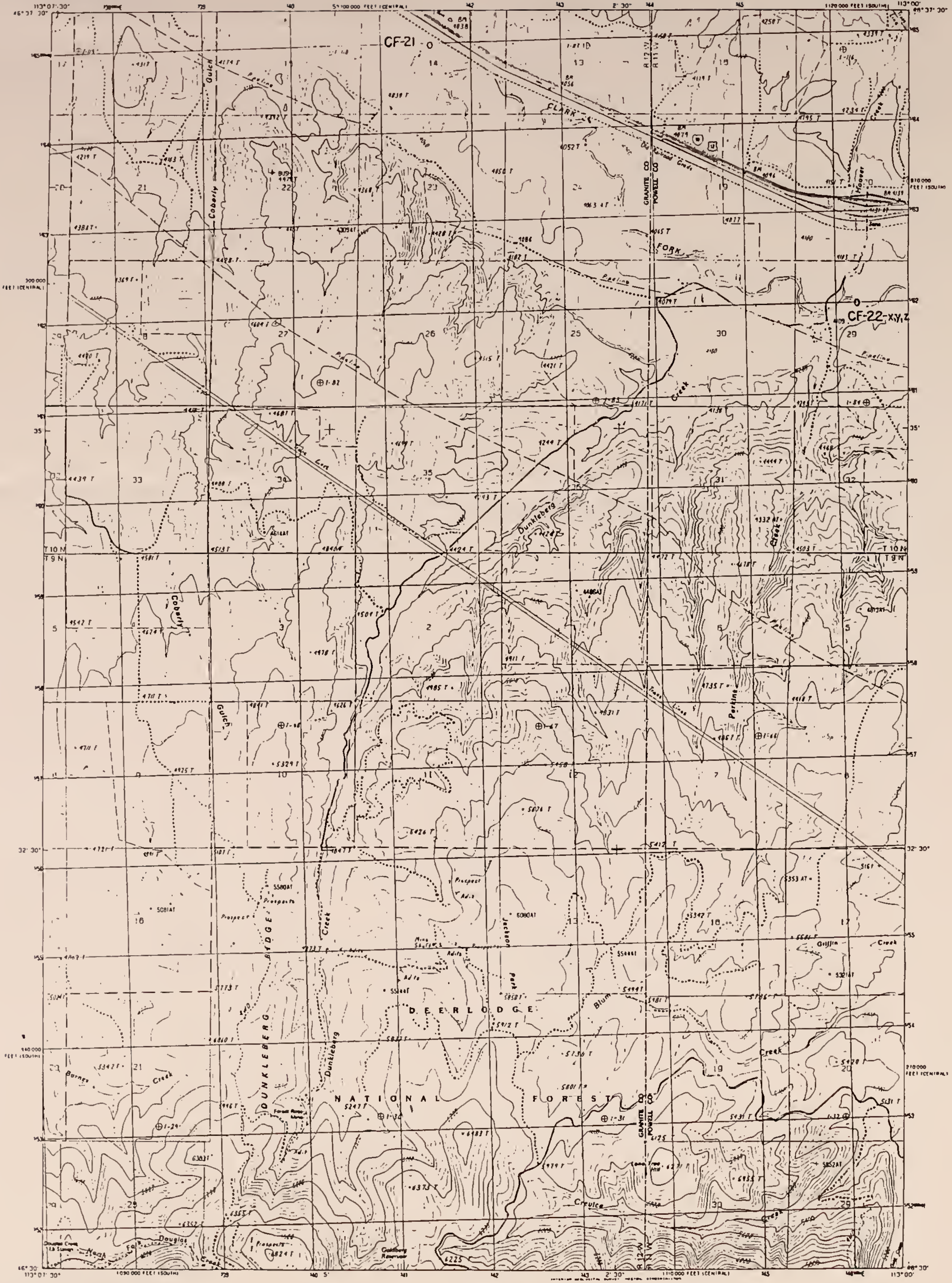
GEOLOGICAL SURVEY

DUNKLEBERG CREEK QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY [illegible]
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN [illegible]
FIELD CHECKED [illegible] MAP EDITED [illegible]
PROJECTION LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR ZONE 12
10 000-FOOT STATE GRID TICKS MONTANA, SOUTH ZONE
MONTANA, CENTRAL ZONE
UTM GRID DECLINATION [illegible] WEST
[illegible] MAGNETIC NORTH DECLINATION [illegible] EAST
VERTICAL DATUM NATIONAL GEODETIC VERTICAL DATUM OF [illegible]
HORIZONTAL DATUM [illegible] NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983 move the projection lines as shown by dashed corner ticks ([illegible] meters north and [illegible] meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

No distinction is made between houses, barns, and other buildings

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of photographs.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET

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OR RESTON, VIRGINIA 22092

MONTANA
QUADRANGLE LOCATION

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail

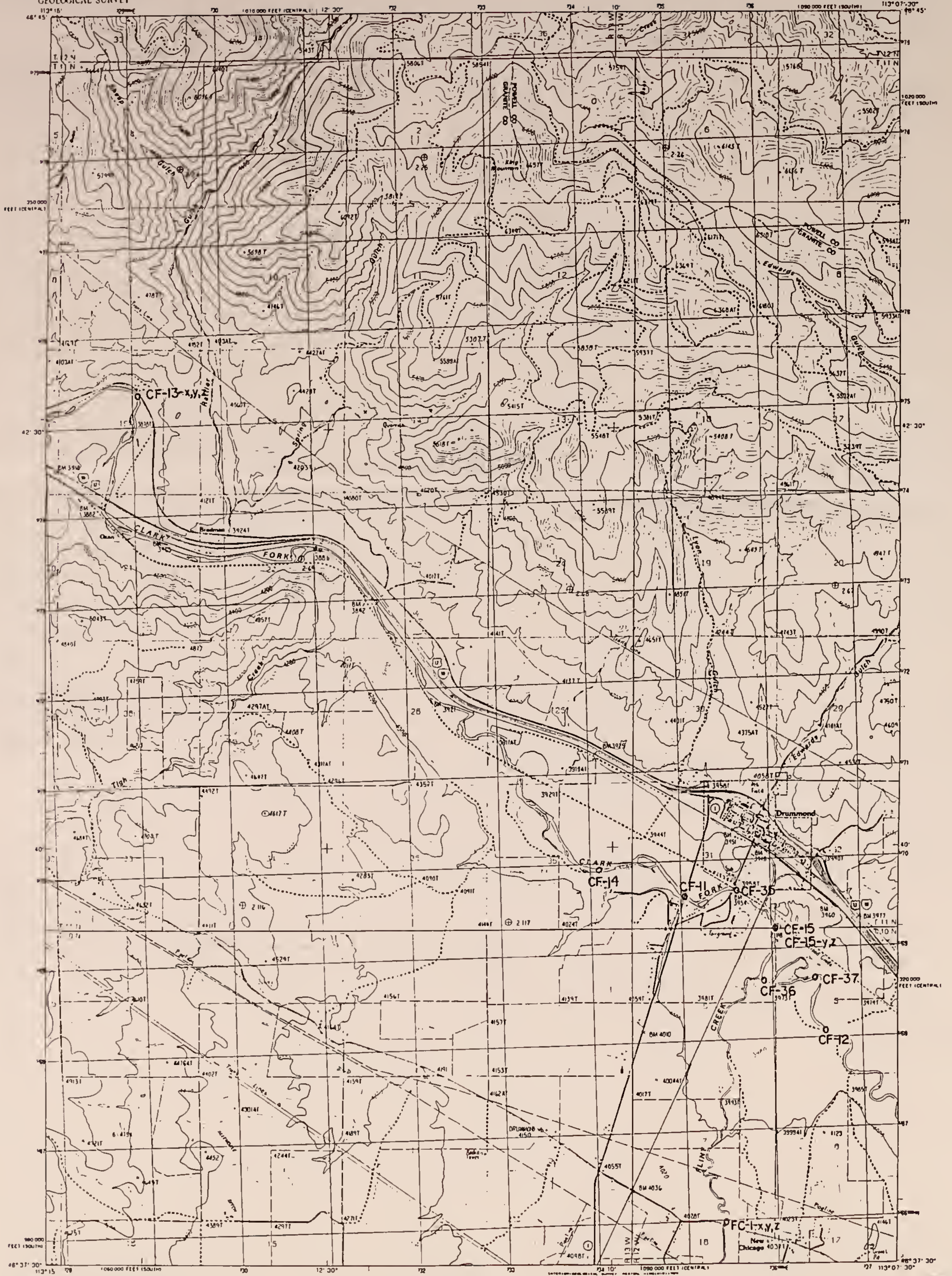
Interstate Route U.S. Route State Route

DUNKLEBERG CREEK, MONTANA
PROVISIONAL EDITION 1989

46113-F1-TF-024

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

DRUMMOND QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



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CONTROL BY ... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN ... [illegible]
FIELD CHECKED [illegible] MAP EDITED ... [illegible]
PROJECTION ... LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR ZONE 12
10 000-FOOT STATE GRID TICKS ... MONTANA, SOUTH ZONE
MONTANA, CENTRAL ZONE
UTM GRID DECLINATION ... [illegible] WEST
[illegible] MAGNETIC NORTH DECLINATION ... 17° EAST
VERTICAL DATUM ... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM ... 1927 NORTH AMERICAN DATUM
To place on the predicted North American Datum of 1983 move the projection lines as shown by dashed corner ticks ([illegible] meters north and [illegible] meters east)
There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map
[illegible]

PROVISIONAL MAP
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SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET
To convert feet to meters multiply by .3048
To convert meters to feet multiply by 3.2808

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MONTANA
QUADRANGLE LOCATION

ADJOINING 7.5' QUADRANGLE NAMES

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Missoula, Montana [illegible]
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ROAD LEGEND

Improved Road
Unimproved Road
Trail
Interstate Route
U.S. Route
State Route

DRUMMOND, MONTANA
PROVISIONAL EDITION 1989
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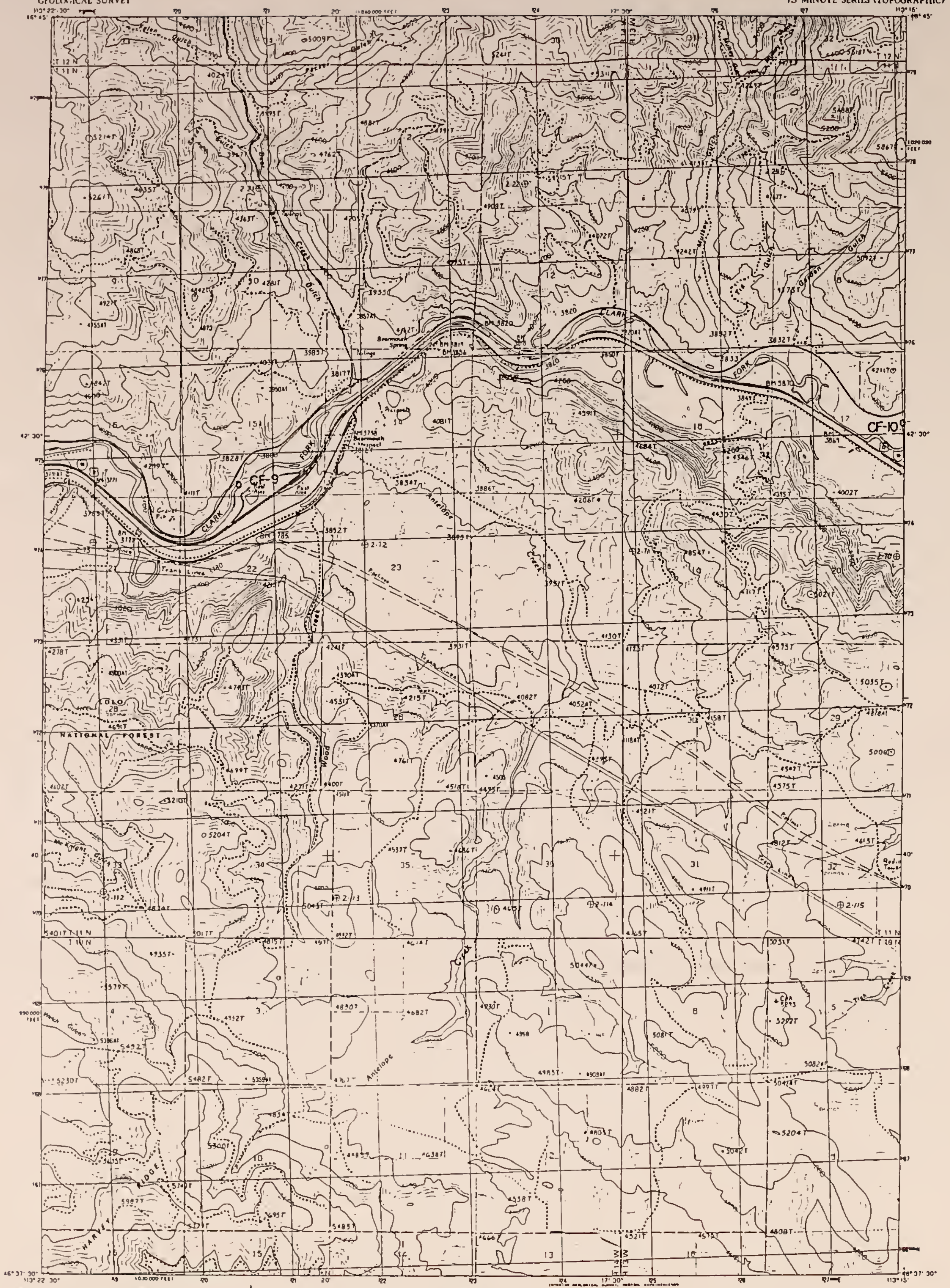
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEARMOUTH QUADRANGLE
MONTANA-GRANITE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



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CONTROL BY ...... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN ...... [illegible]
FIELD CHECKED [illegible] MAP EDITED ...... [illegible]
PROJECTION ...... LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR ZONE 12
10 000-FOOT STATE GRID TICKS ...... MONTANA, SOUTH ZONE
UTM GRID DECLINATION ...... [illegible] WEST
[illegible] MAGNETIC NORTH DECLINATION ...... [illegible] EAST
VERTICAL DATUM ...... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM ...... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks ([illegible] meters north and [illegible] meters east)

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

No distinction made between houses, barns, and other buildings

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of photography.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET

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OR RESTON, VIRGINIA 22092

QUADRANGLE LOCATION

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road ......
Unimproved Road ......
Trail ......

Interstate Route U.S. Route State Route

BEARMOUTH, MONTANA
PROVISIONAL EDITION 1989

46113-F3-TF-024

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MISSOULA, MONTANA 59801
PHONE [illegible]

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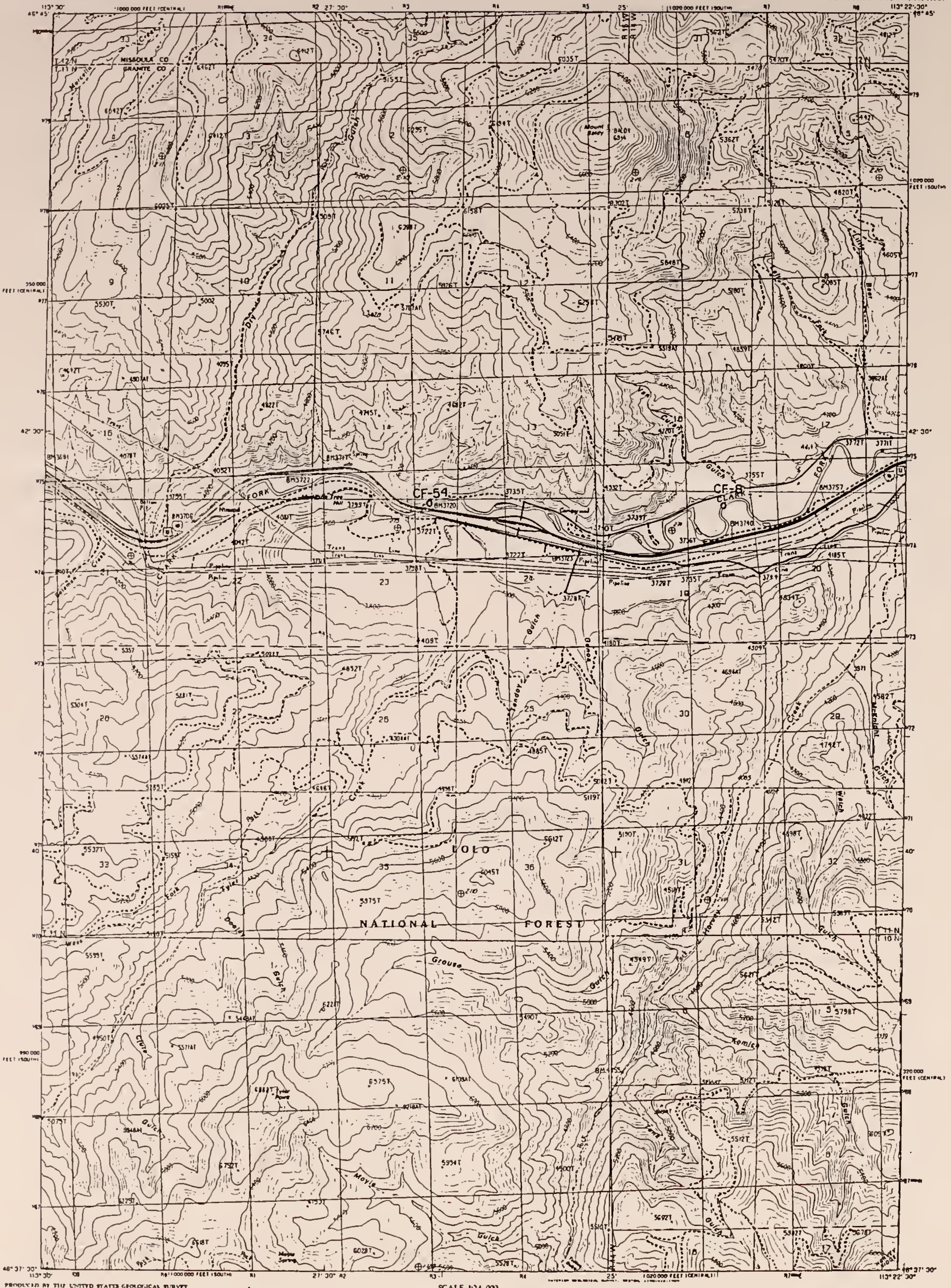
MEDICINE TREE HILL QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY

To place on the predicted North American Datum of 1983 move the projection lines as shown by dashed corner ticks

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

PROVISIONAL MAP
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SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

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OR RESTON, VIRGINIA 22092

MONTANA
QUADRANGLE LOCATION

ROAD LEGEND

Improved Road
Unimproved Road
Trail

Interstate Route U.S. Route State Route

MEDICINE TREE HILL, MONTANA
PROVISIONAL EDITION 1989

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Phone 543-

UNITED STATES
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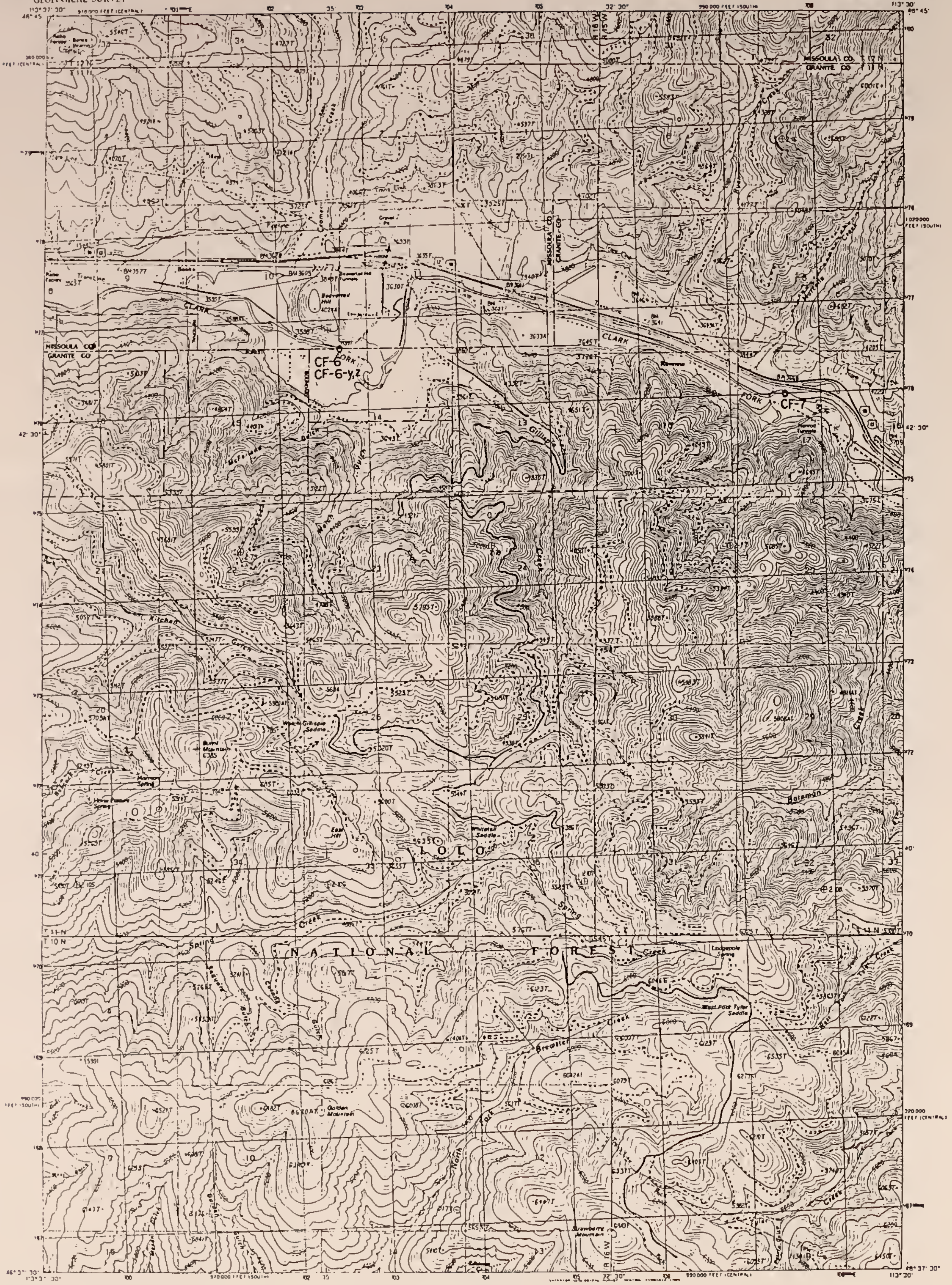
RAVENNA QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



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CONTROL BY [illegible]
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN [illegible]
FIELD CHECKED [illegible] MAP EDITED [illegible]
PROJECTION LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR ZONE 12
10 000-FOOT STATE GRID TICKS MONTANA, SOUTH ZONE
MONTANA, CENTRAL ZONE
UTM GRID DECLINATION [illegible] WEST
1989 MAGNETIC NORTH DECLINATION 17° EAST
VERTICAL DATUM NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM 1927 NORTH AMERICAN DATUM

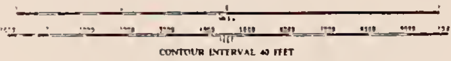
To place on the predicted North American Datum of 1983 move the projection lines as shown by dashed corner ticks ([illegible] meters north and [illegible] meters east)

There may be private inholdings within the boundaries of any federal and state Reservations shown on this map

[illegible] houses, barns, and other buildings

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of photographs

SCALE 1:24 000



CONTOUR INTERVAL 40 FEET

To convert feet to meters multiply by .3048
To convert meters to feet multiply by 3.2808

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
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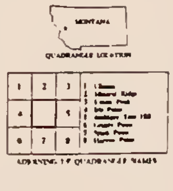
OR RESTON, VIRGINIA 22092



ROAD LEGEND

Improved Road . . . .
Unimproved Road . . . .
Trail . . . .
Interstate Route ☐ U.S. Route ○ State Route

RAVENNA, MONTANA
PROVISIONAL EDITION 1989

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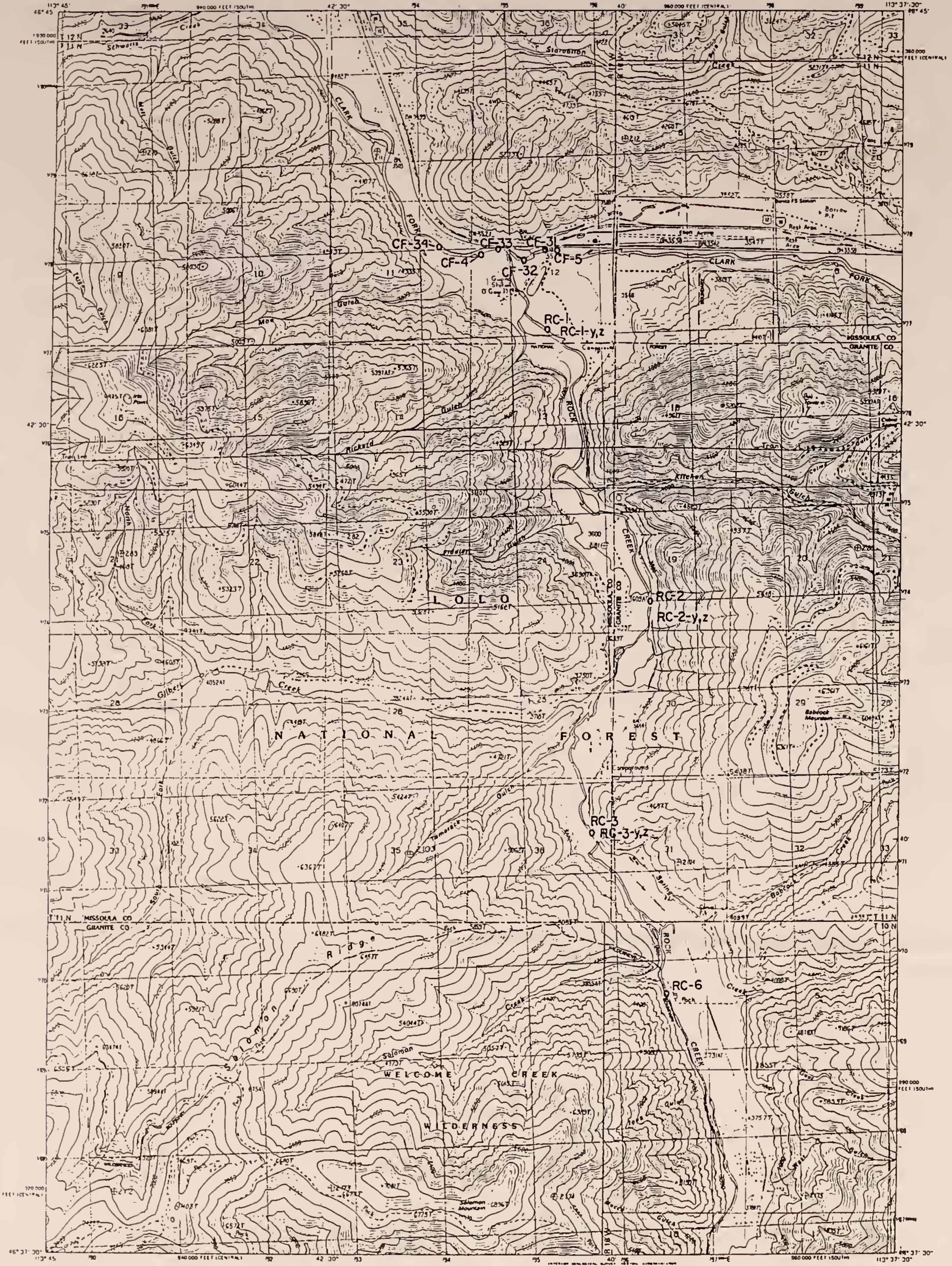
IRIS POINT QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY ... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN ... [illegible]
FIELD CHECKED [illegible] MAP EDITED ... [illegible]
PROJECTION ... LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR ... ZONE 12
10 000-FOOT STATE GRID TICKS ... MONTANA, CENTRAL ZONE
MONTANA, SOUTH ZONE
UTM GRID DECLINATION ... [illegible] WEST
1989 MAGNETIC NORTH DECLINATION ... 17° EAST
VERTICAL DATUM ... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM ... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983 move the projection lines as shown by dashed corner ticks (11 meters north and 69 meters east)

There may be private inholdings within the boundaries of any federal and state Reservations shown on this map

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of photography.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
To convert feet to meters multiply by .3048
To convert meters to feet multiply by 3.2808

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225
OR RESTON, VIRGINIA 22092

QUADRANGLE LOCATION

ROAD LEGEND

Improved Road ....
Unimproved Road ....
Trail ....

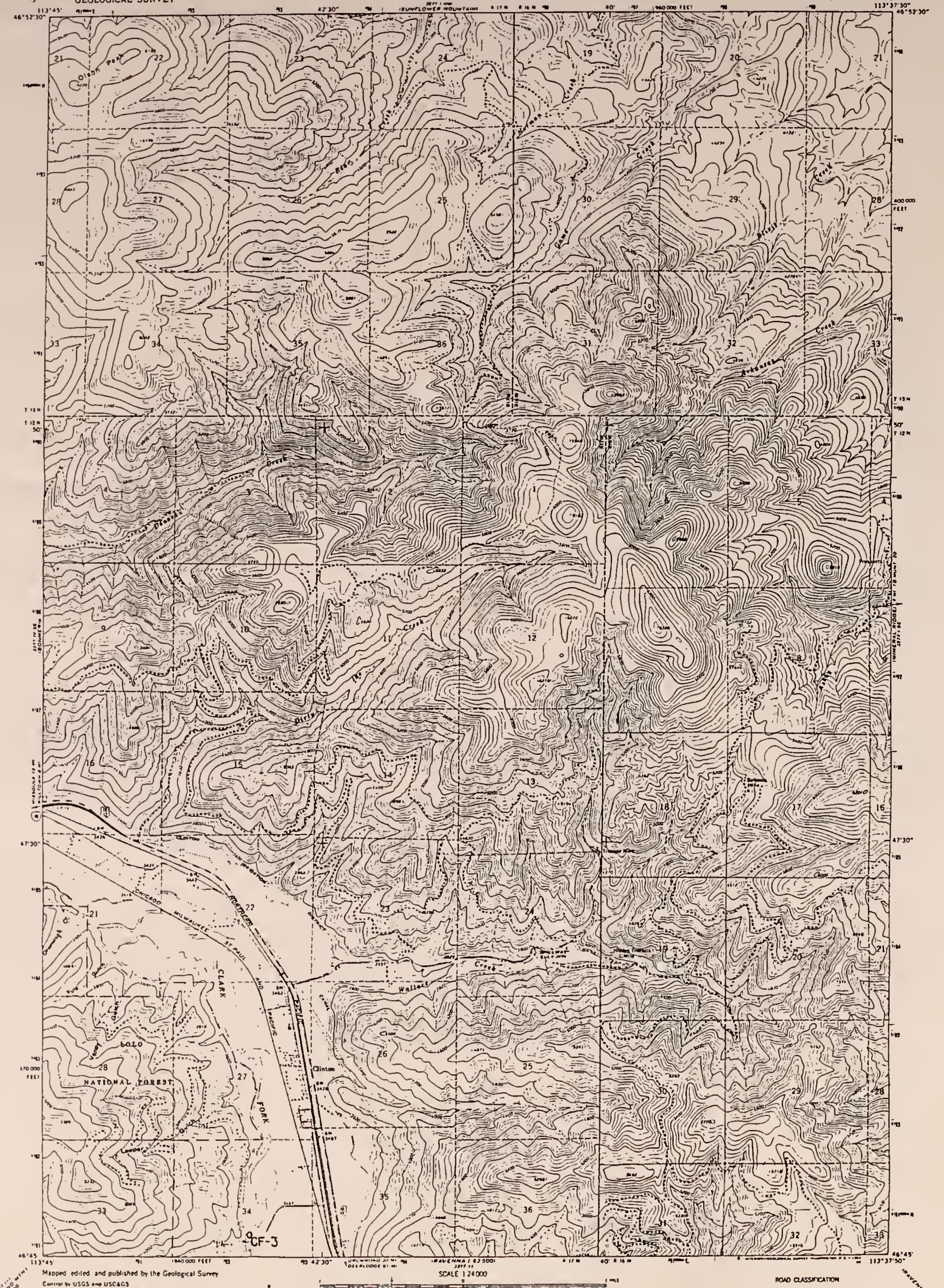
Interstate Route U.S. Route State Route

IRIS POINT, MONTANA
PROVISIONAL EDITION 1989

[illegible]

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CLINTON QUADRANGLE
MONTANA–MISSOULA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped edited and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1961 Field checked 1965

Polyconic projection 1927 North American datum
10 000 foot grid based on Montana coordinate system, central zone
1000 meter Universal Transverse Mercator grid ticks, zone 12 shown in blue

Fine red dashed lines indicate selected fence lines

UTM GRID AND 1965 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24000

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20 FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U S GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

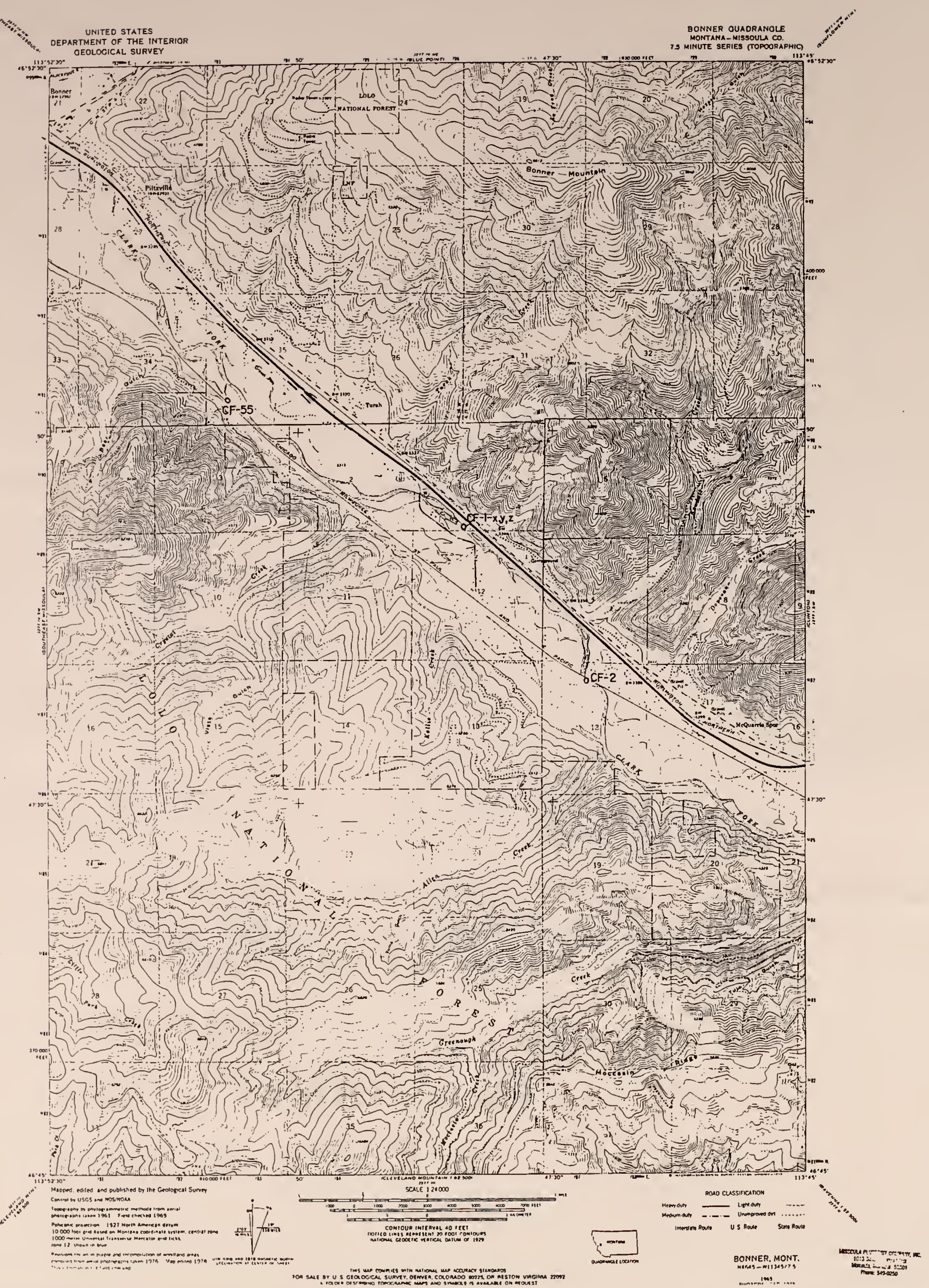
Heavy duty
Light duty
Medium duty
Unimproved dirt
Interstate Route
U S Route

QUADRANGLE LOCATION

CLINTON, MONT.
N4645—W11337.5/7.5

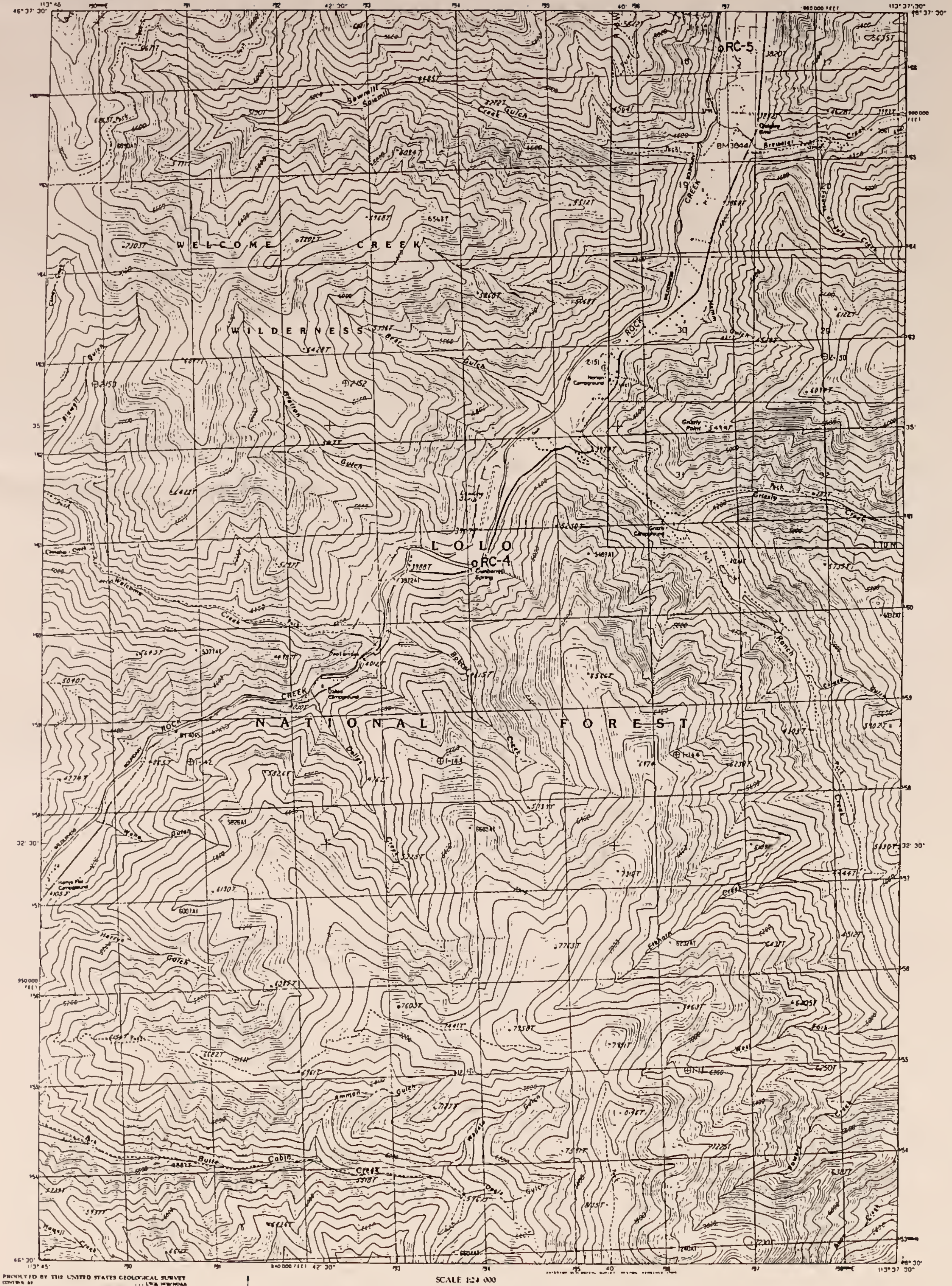
1965

AMS 3277 I SW—SERIES V894


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BONNER QUADRANGLE
MONTANA–MISSOULA CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
113°52'30"
46°52'30"
50'
47'30"
113°45'
46°45'
BLUE POINT
Bonner
Piltzville
LOLO
NATIONAL FOREST
Bonner Mountain
BURLINGTON NORTHERN
CLARK
FORK
Turah
CF-55
CF-1-x,y,z
CF-2
CHICAGO
MILWAUKEE
ST PAUL
AND
PACIFIC
McQuarrie Spur
Quartz
Gulch
Crystal
Vista
Kelley
Deer
Dawson
Creek
LOLO
NATIONAL
FOREST
Allen
Greenough
Moccasin
Ridge
Little
Pond
Rio
400 000 FEET
370 000 FEET
910 000 FEET
930 000 FEET
CLEVELAND MOUNTAIN 1:62 500
SOUTHEAST MISSOULA
CLINTON
NORTHEAST MISSOULA
GUNPOWDER HILL
CLEVELAND MTN
RAVENNA 1:62 500
Mapped, edited, and published by the Geological Survey
Control by USGS and NOS/NOAA
Topography by photogrammetric methods from aerial photographs taken 1961. Field checked 1965
Polyconic projection. 1927 North American datum
10,000-foot grid based on Montana coordinate system, central zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue
Revisions shown in purple and recompilation of woodland areas compiled from aerial photographs taken 1976. Map edited 1978
UTM GRID AND 1978 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
SCALE 1:24 000
1 MILE
7000 FEET
1 KILOMETER
CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20 FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U S GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
ROAD CLASSIFICATION
Heavy duty
Light duty
Medium duty
Unimproved dirt
Interstate Route
U S Route
State Route
MONTANA
QUADRANGLE LOCATION
BONNER, MONT.
N4645—W11345/7.5
1965
Phone: 549-0250

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GRIZZLY POINT QUADRANGLE
MONTANA-GRANITE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN .... [illegible]
FIELD CHECKED .... [illegible] MAP EDITED .... [illegible]
PROJECTION .... LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10 000-FOOT STATE GRID TICKS .... MONTANA, SOUTH ZONE
UTM GRID DECLINATION .... [illegible] WEST
1989 MAGNETIC NORTH DECLINATION .... [illegible] EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983 move the projection lines as shown by dashed corner ticks [illegible]

There may be private inholdings within the boundaries of any federal and state reservations shown on this map

[illegible]

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of photographs.

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO [illegible]
OR RESTON, VIRGINIA 22092

QUADRANGLE LOCATION

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail

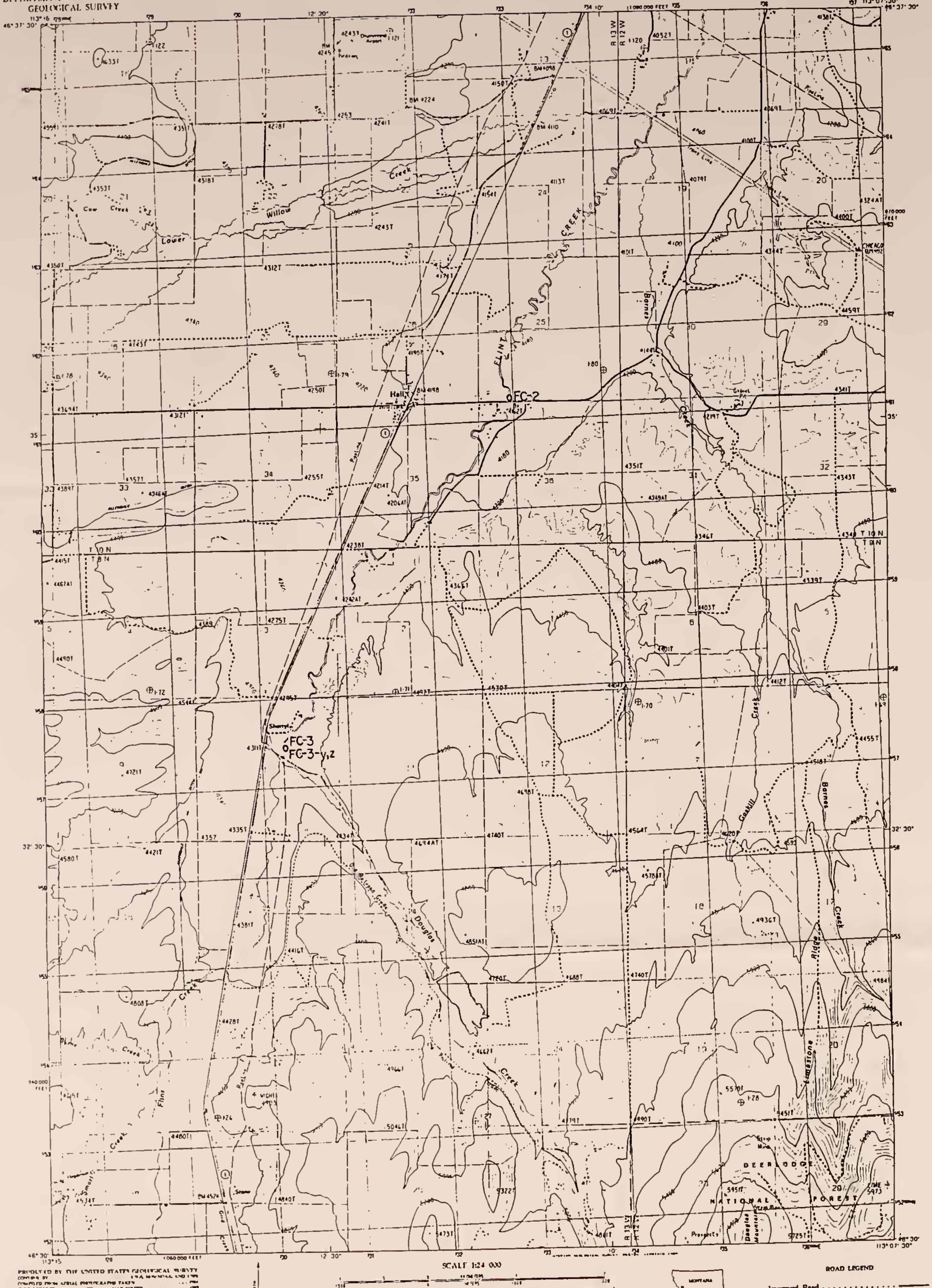
Interstate Route U.S. Route State Route

GRIZZLY POINT, MONTANA
PROVISIONAL EDITION 1989

MISSOULA BLUEPRINT COMPANY, [illegible]
1013 South Avenue West
Missoula, Montana 59801
Phone 549-0250

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HALL QUADRANGLE
MONTANA-GRANITE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY [illegible]
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN [illegible]
FIELD CHECKED [illegible] MAP EDITED [illegible]
PROJECTION LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR ZONE 12
10 000-FOOT STATE GRID TICKS MONTANA, SOUTH ZONE
UTM GRID DECLINATION [illegible] WEST
1988 MAGNETIC NORTH DECLINATION 17° EAST
VERTICAL DATUM NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM 1927 NORTH AMERICAN DATUM
To place on the predicted North American Datum of 1983 move the projection lines as shown by dashed corner ticks ([illegible] meters north and [illegible] meters east)
There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map
No distinction made between houses, barns and other buildings

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of photographs.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET
To convert feet to meters multiply by 0.3048
To convert meters to feet multiply by 3.2808

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225
OR RESTON, VIRGINIA 22092

MONTANA
QUADRANGLE LOCATION

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road .... ▬▬
Unimproved Road .... - - - -
Trail .... - - - -

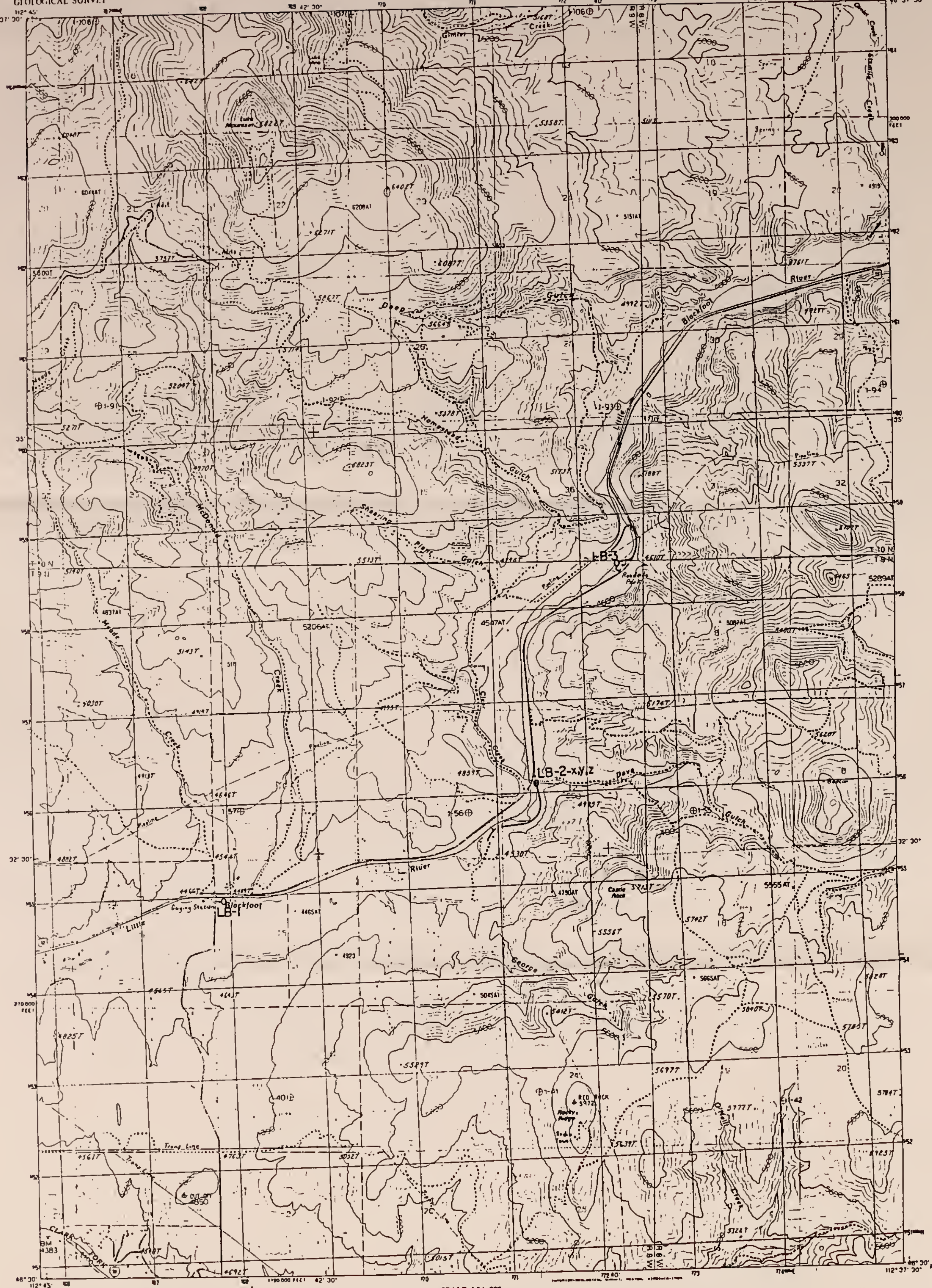
Interstate Route □ U.S. Route ○ State Route

HALL, MONTANA
PROVISIONAL EDITION 1989
46113-E2-TF-024

MISSOULA BLUEPRINT COMPANY
1413 SOUTH AVENUE WEST
MISSOULA, MONTANA 59801
PHONE [illegible]

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

LUKE MOUNTAIN QUADRANGLE
MONTANA-POWELL CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS, NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN .... [illegible]
FIELD CHECKED .... [illegible] MAP EDITED .... [illegible]
PROJECTION .... LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10 000-FOOT STATE GRID TICKS .... MONTANA, CENTRAL ZONE
UTM GRID DECLINATION .... [illegible] WEST
[illegible] MAGNETIC NORTH DECLINATION .... [illegible] EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks ([illegible] meters north and [illegible] meters east)

There may be private inholdings within the boundaries of any federal and State Reservations shown on this map

No distinction made between houses, barns, and other buildings

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of photographs. 1

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225
OR RESTON, VIRGINIA 22092

QUADRANGLE LOCATION

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road ....
Unimproved Road ....
Trail ....

Interstate Route U.S. Route State Route

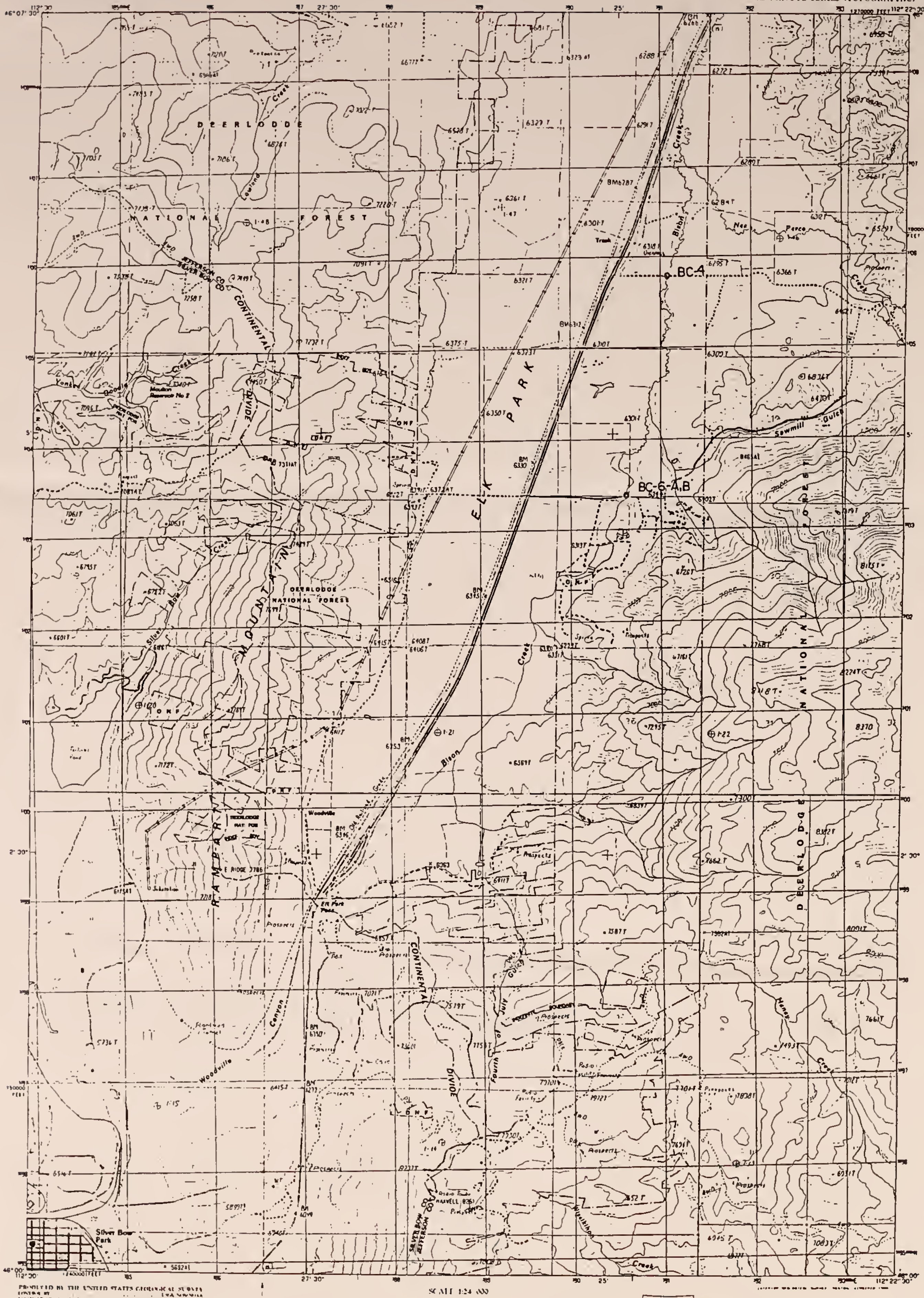
LUKE MOUNTAIN, MONTANA
PROVISIONAL EDITION 1989

46112-F6-TF-024

MISSOULA BLUEPRINT COMPANY

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

ELK PARK PASS QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY

To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks

There may be private inholdings within the boundaries of any Federal and State Reservations shown on this map

All marginal data and lettering generated and positioned by [illegible]

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTAL CONTOUR INTERVAL 20 FEET

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225
OR RESTON, VIRGINIA 22092

MONTANA
QUADRANGLE LOCATION

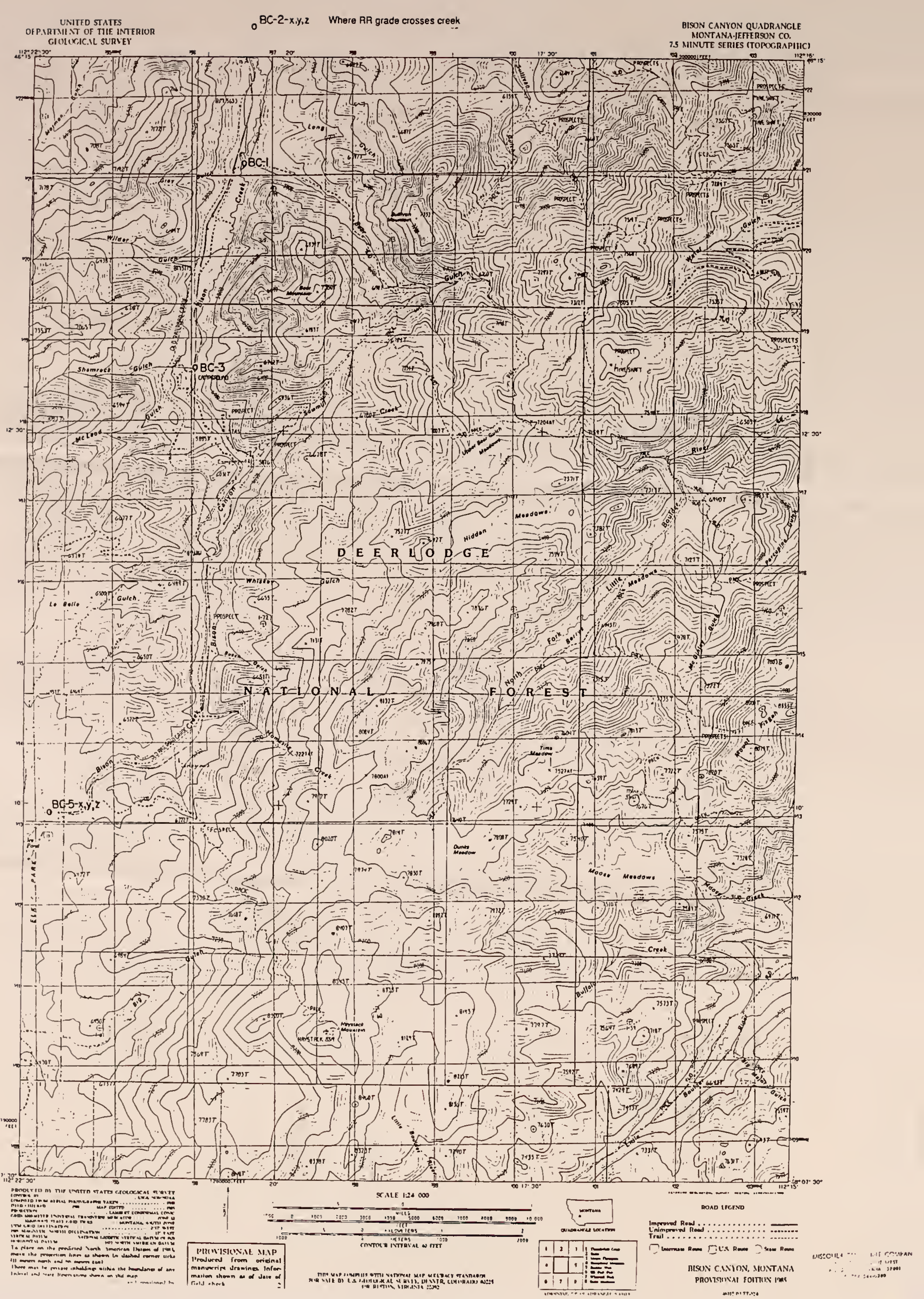
ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road
Unimproved Road
Trail

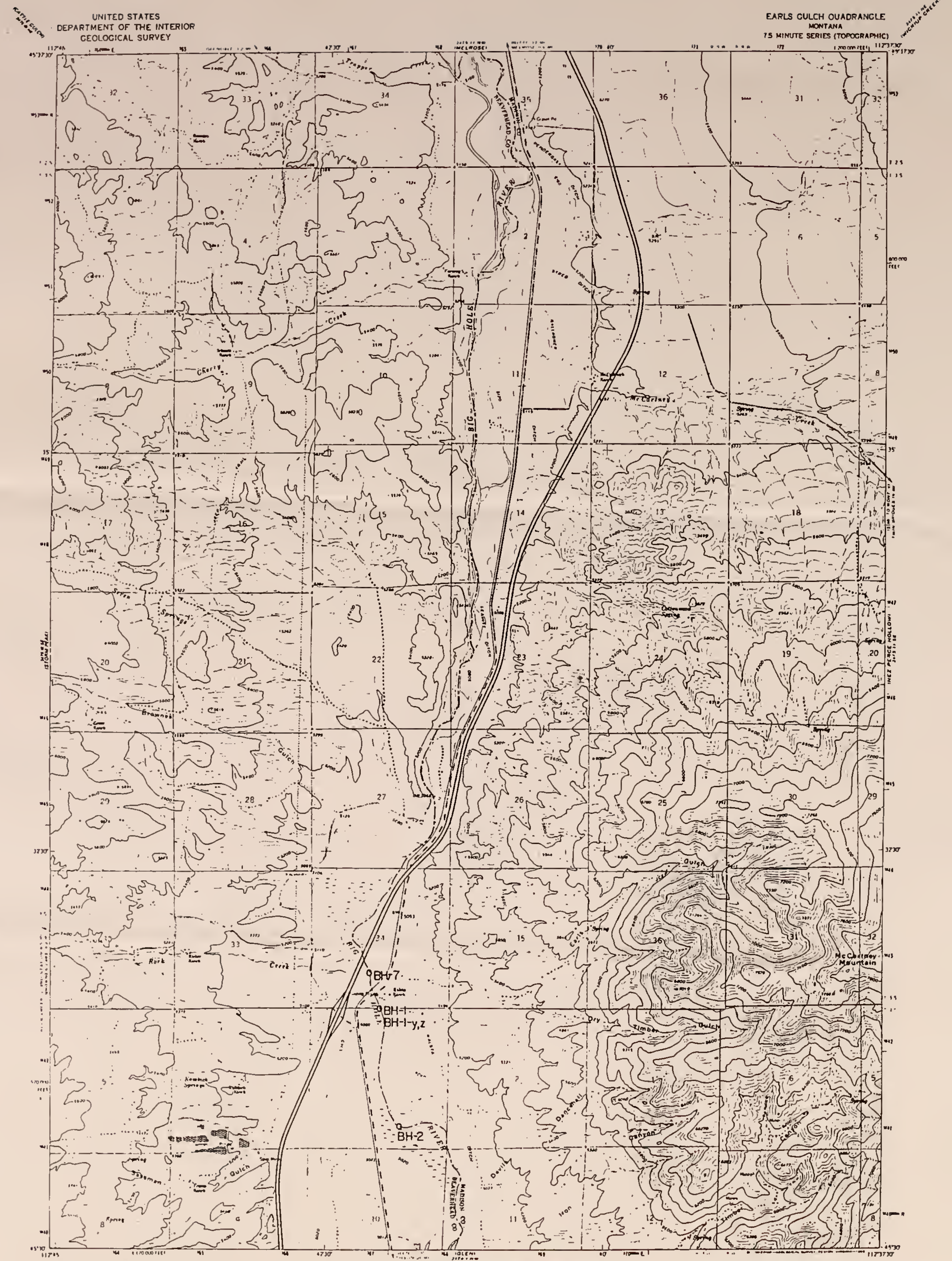
Interstate Route　U.S. Route　State Route

ELK PARK PASS, MONTANA
PROVISIONAL EDITION 1985


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BC-2-x,y,z
Where RR grade crosses creek
BISON CANYON QUADRANGLE
MONTANA-JEFFERSON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
BC-1
BC-3
BC-5-x,y,z
Long Gulch
Grey Gulch
Wilder Gulch
Bison Creek
Bison Canyon
Shamrock Gulch
CAMPGROUND
McLeod Gulch
Whiskey Gulch
La Belle Gulch
PROSPECT
PROSPECTS
Bison Mountain
Sullivan Mountain
Upper Bear Gulch Meadows
Hidden Meadows
Boulder River
Little Meadows
North Fork
Porcupine Gulch
DEERLODGE
NATIONAL FOREST
Homestake Creek
Time Meadow
Dunks Meadow
Moose Meadows
Moose Creek
Buffalo Creek
Big Gulch
Haystack Mountain
Little Boulder River
ELK PARK
SCALE 1:24 000
MILES
FEET
KILOMETERS
METERS
CONTOUR INTERVAL 40 FEET
QUADRANGLE LOCATION
MONTANA
PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.
ROAD LEGEND
Improved Road
Unimproved Road
Trail
Interstate Route
U.S. Route
State Route
BISON CANYON, MONTANA
PROVISIONAL EDITION 1985

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

EARLS GULCH QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey

Control by USGS and NOS/NOAA

Topography by photogrammetric methods from aerial photographs taken 1956. Field checked 1961

Polyconic projection. 1927 North American Datum
10,000-foot grid based on Montana coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

Fine red dashed lines indicate selected fence lines

To place on the predicted North American Datum 1983 move the projection lines 11 meters north and 67 meters east as shown by dashed corner ticks

UTM GRID AND 1988 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24000

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

Primary highway, all weather, hard surface	Light-duty road, all weather, improved surface
Secondary highway, all weather, hard surface	Unimproved road, fair or dry weather

Interstate Route ☐ U.S. Route ○ State Route

MONTANA
QUADRANGLE LOCATION

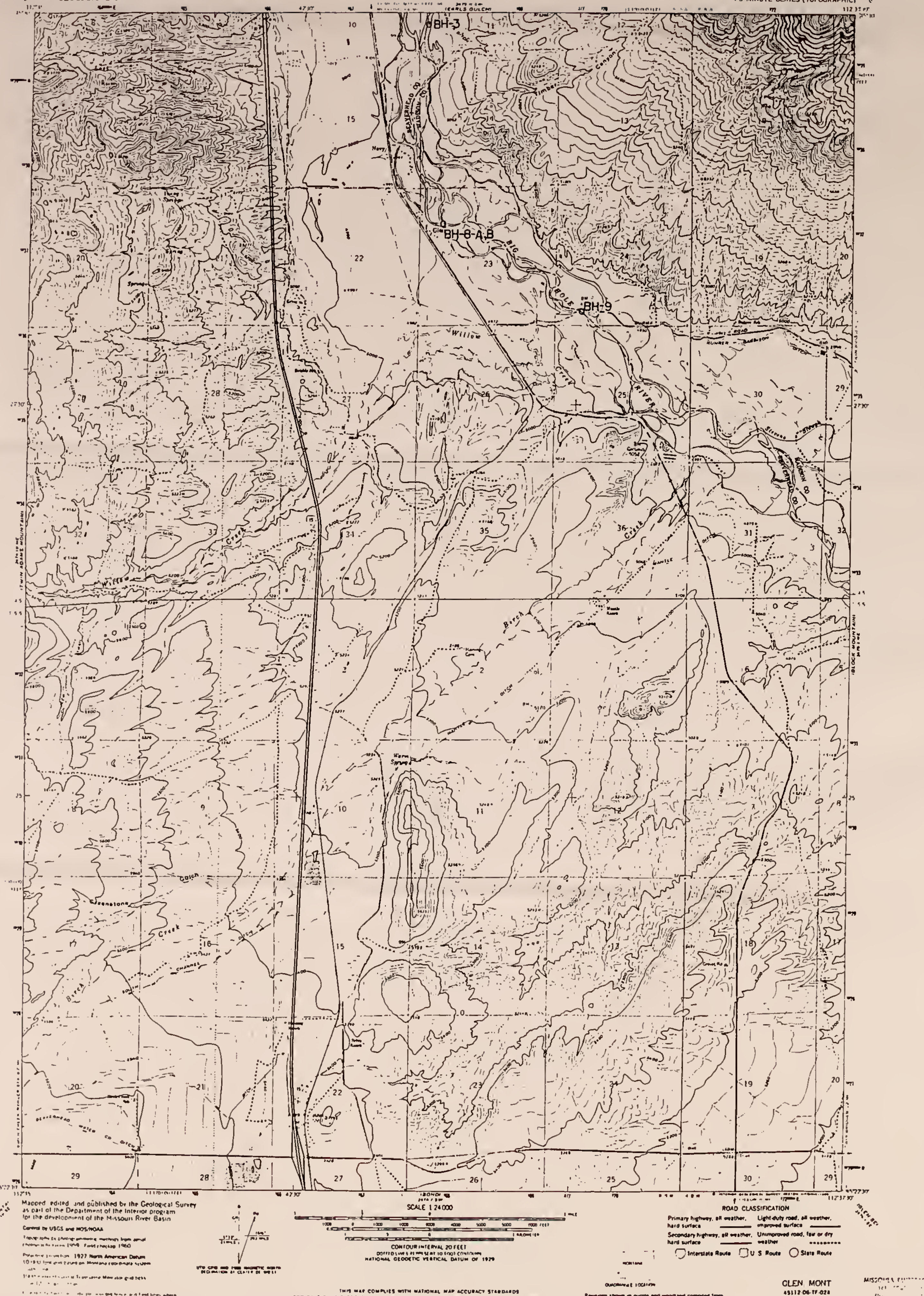
EARLS GULCH, MONT.
45112-E6-TF-024

1961
PHOTOREVISED 1988

MISSOULA BLUEPRINT COMPANY
1613 SOUTH AVENUE WEST
MISSOULA, MONTANA 59801
PHONE 549-0230

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GLEN QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey
as part of the Department of the Interior program
for the development of the Missouri River Basin

Control by USGS and NOS/NOAA

Topography by photogrammetric methods from aerial photographs taken 1958. Field checked 1960

Polyconic projection. 1927 North American Datum

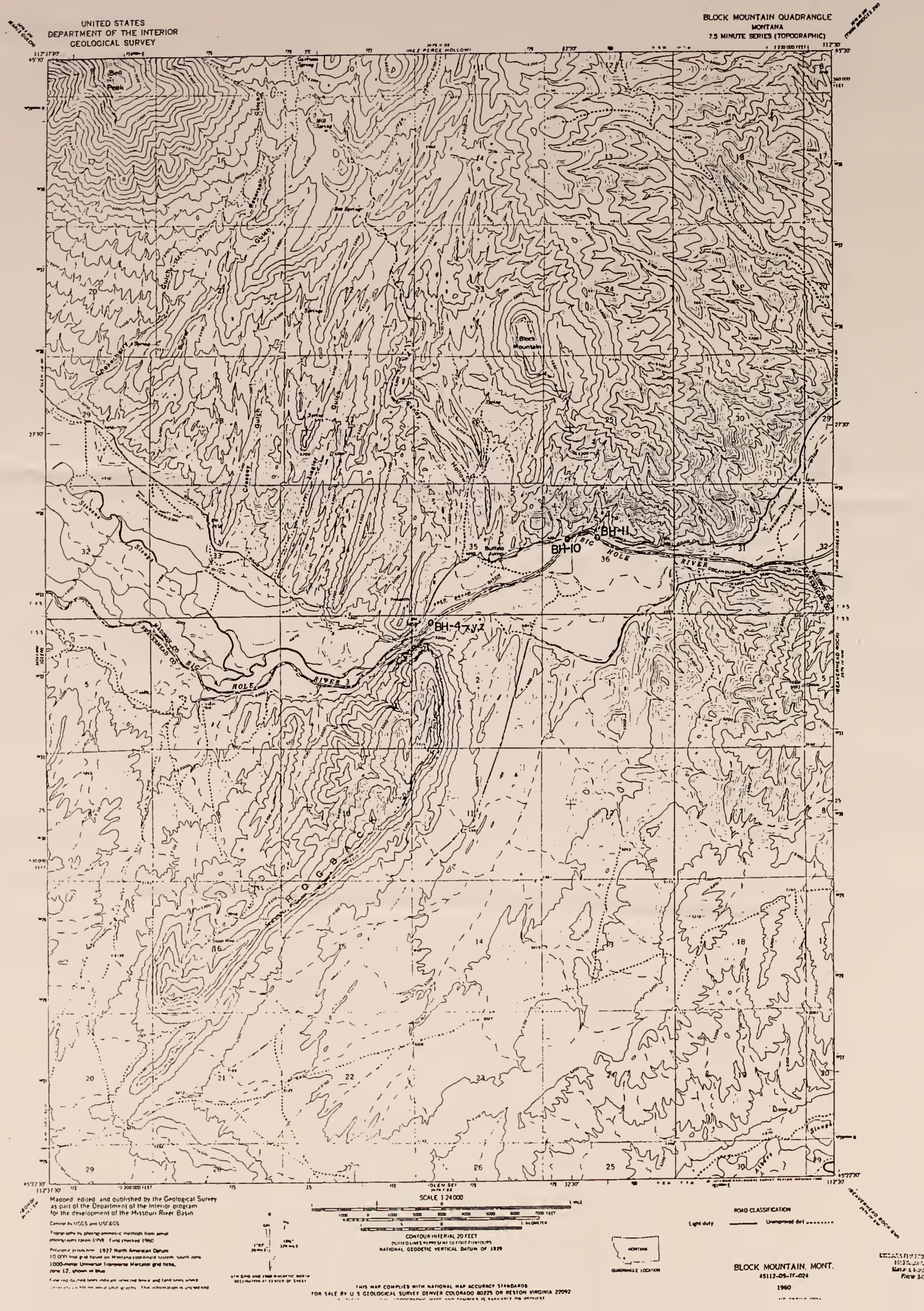
DOTTED LINES REPRESENT 10 FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U S GEOLOGICAL SURVEY, DENVER COLORADO 80225 OR RESTON VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

Revisions shown in purple and woodland compiled from aerial photographs taken 1984 and other source data
Partial field check by U. S. Forest Service. Map edited 1988

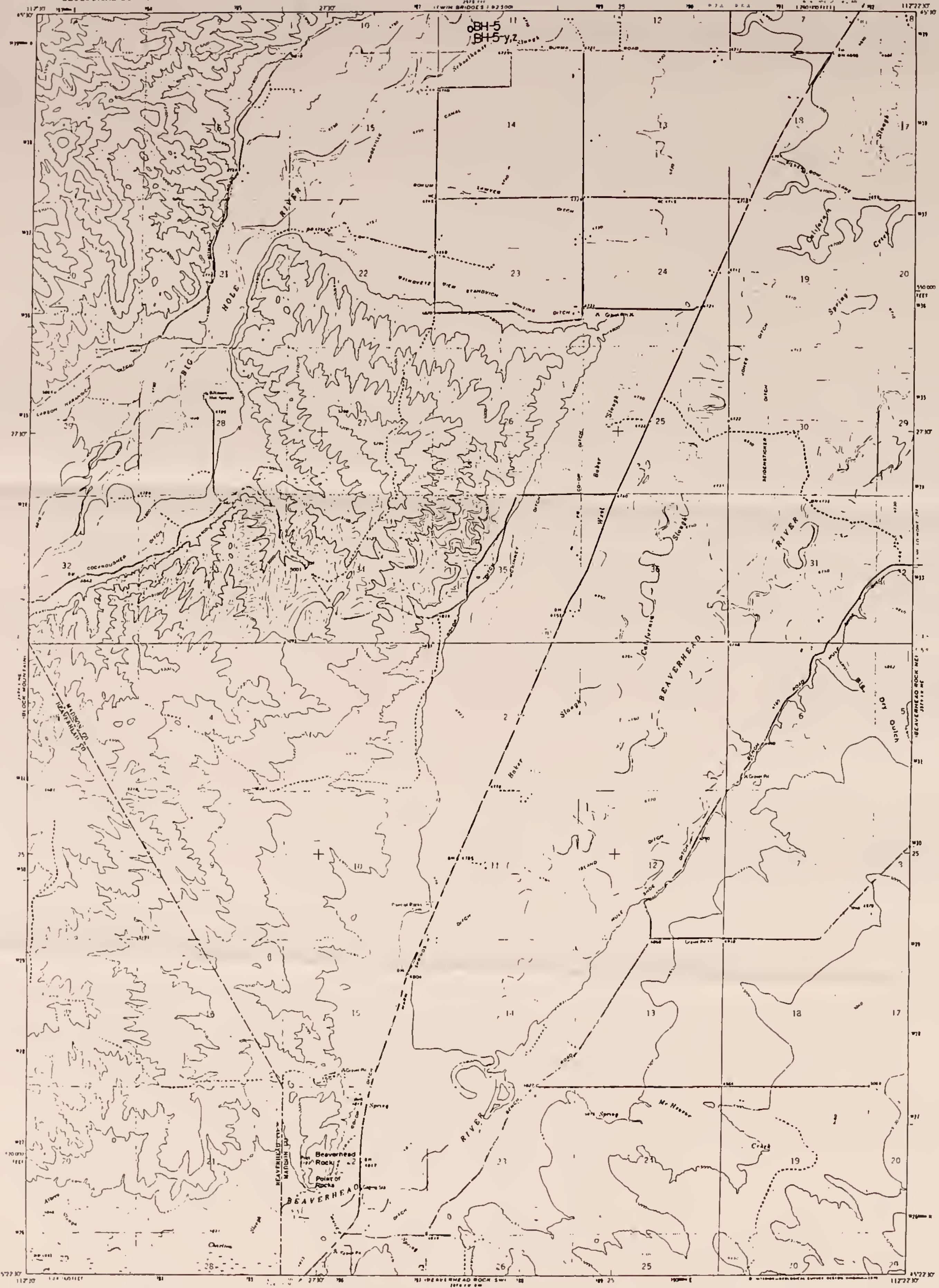
GLEN, MONT
45112-D6-TF-024
1960
PHOTOREVISED 1988

MISSOULA [illegible] COMPANY


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BLOCK MOUNTAIN QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)
NEZ PERCE HOLLOW
Bell Peak
Block Mountain
Buffalo Jump
BH-11
BH-10
BH-4 x,y,z
BIG HOLE RIVER
BIG HOLE RIVER
Hollow
Gulch
Gulch
Gulch
Spring
Slough
HOGBACK
BEAVERHEAD ROCK
SCALE 1:24000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER
CONTOUR INTERVAL 20 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
Mapped, edited, and published by the Geological Survey
as part of the Department of the Interior program
for the development of the Missouri River Basin
Control by USGS and USC&GS
Topography by photogrammetric methods from aerial photographs taken 1959. Field checked 1960
Polyconic projection. 1927 North American Datum
10,000-foot grid based on Montana coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue
UTM GRID AND 1960 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U S GEOLOGICAL SURVEY DENVER COLORADO 80225 OR RESTON VIRGINIA 22092
ROAD CLASSIFICATION
Light-duty
Unimproved dirt
MONTANA
QUADRANGLE LOCATION
BLOCK MOUNTAIN, MONT.
45112-D5-TF-024
1960

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEAVERHEAD ROCK QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1960. Field checked 1962

Polyconic projection. 1927 North American datum
10,000-foot grid based on Montana coordinate system, south zone
1000-metre Universal Transverse Mercator grid ticks,
zone 12, shown in blue

Fine red dashed lines indicate selected fence lines

UTM GRID AND 1962 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

MONTANA
QUADRANGLE LOCATION

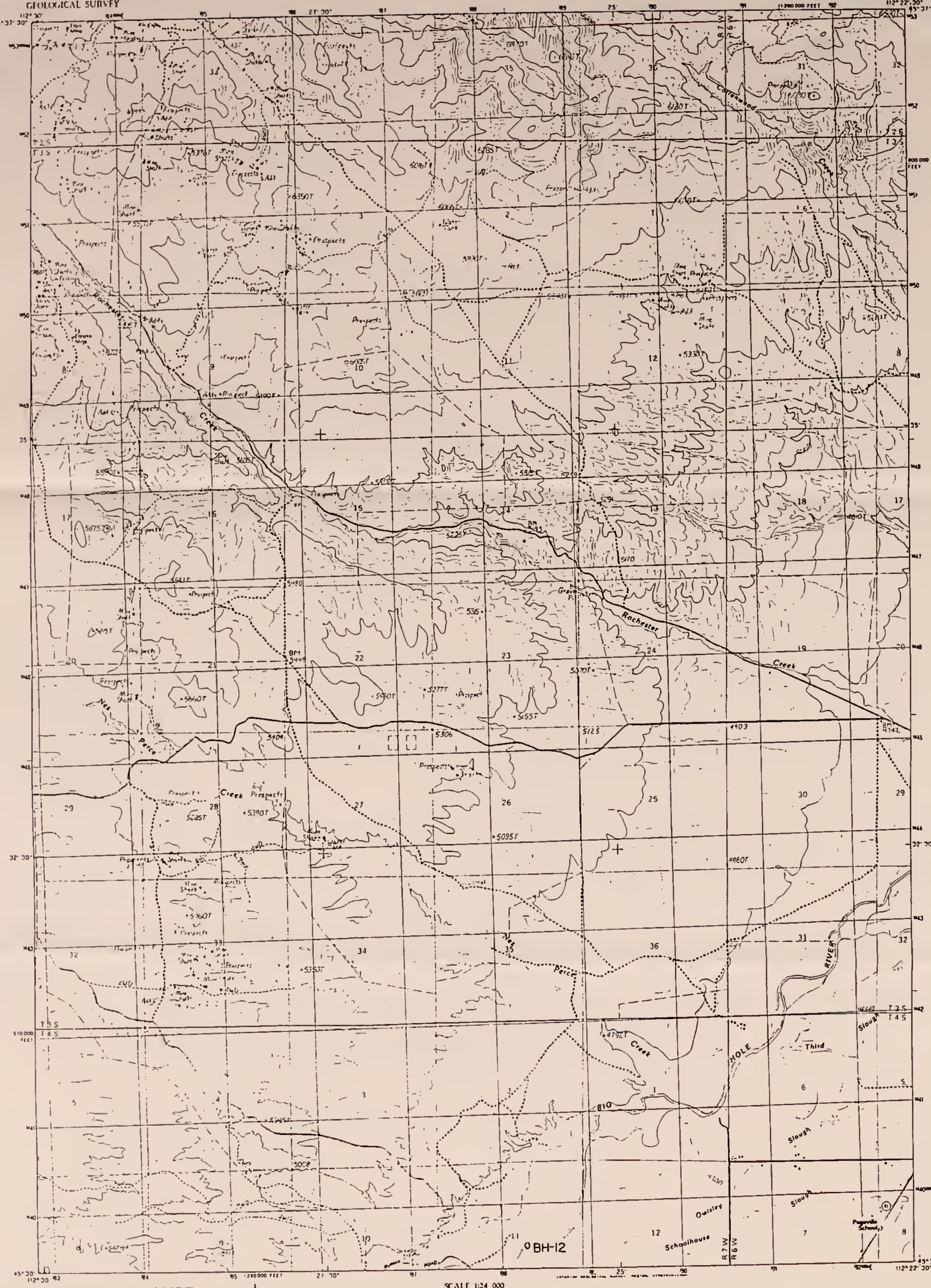
ROAD CLASSIFICATION
Medium duty ——— Light duty ———
Unimproved dirt ....
State Route

BEAVERHEAD ROCK, MONT
N4522.5—W11222.5/7.5

1962

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TWIN BRIDGES SW QUADRANGLE
MONTANA-MADISON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
[illegible]

To place on the predicted North American Datum of 1983 move the projection lines as shown by dashed corner ticks [illegible]

There may be private inholdings within the boundaries of any [illegible] shown on this map.

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check.

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225
OR RESTON, VIRGINIA 22092

QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

ADJOINING 7.5' QUADRANGLE NAMES

ROAD LEGEND

Improved Road . . . . ———
Unimproved Road . . . . - - - - - -
Trail . . . . - - - - - -

Interstate Route U.S. Route State Route

TWIN BRIDGES SW, MONTANA
PROVISIONAL EDITION 1989

[illegible]

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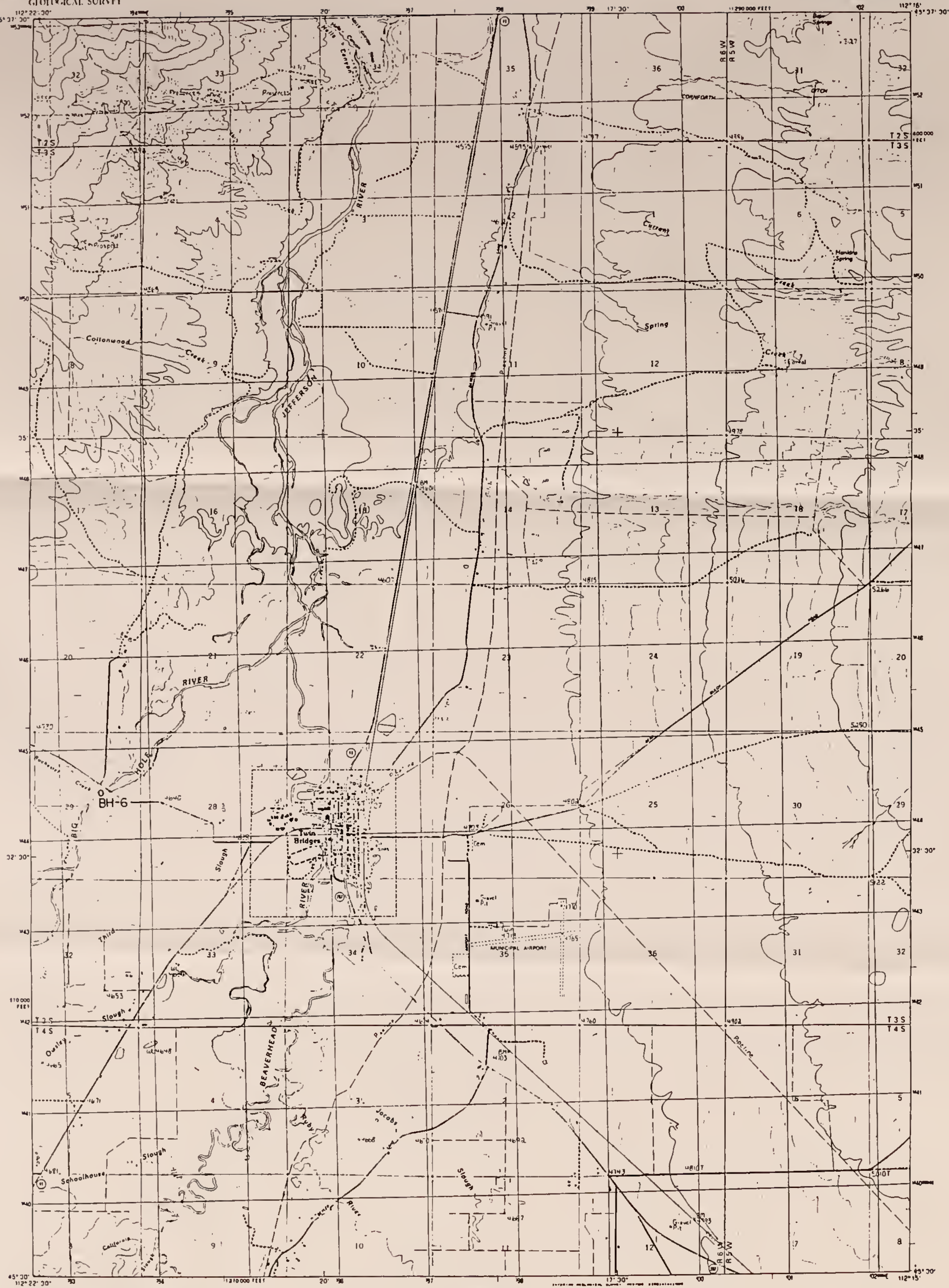
1613 South Avenue West
Missoula, Montana 59801
Phone 549-0250

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TWIN BRIDGES QUADRANGLE
MONTANA-MADISON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY
CONTROL BY .... USGS NOS/NOAA
COMPILED FROM AERIAL PHOTOGRAPHS TAKEN .... [illegible]
FIELD CHECKED .... [illegible]
LIMITED REVIEW FROM AERIAL PHOTOGRAPHS TAKEN .... [illegible]
FIELD CHECKED .... [illegible] MAP EDITED .... [illegible]
PROJECTION .... LAMBERT CONFORMAL CONIC
GRID: 1000-METER UNIVERSAL TRANSVERSE MERCATOR .... ZONE 12
10 000-FOOT STATE GRID TICKS .... MONTANA, SOUTH ZONE
UTM GRID DECLINATION .... [illegible] WEST
1989 MAGNETIC NORTH DECLINATION .... [illegible] EAST
VERTICAL DATUM .... NATIONAL GEODETIC VERTICAL DATUM OF 1929
HORIZONTAL DATUM .... 1927 NORTH AMERICAN DATUM
To place on the predicted North American Datum of 1983, move the projection lines as shown by dashed corner ticks [illegible] meters north and [illegible] meters east
[illegible] within the boundaries of [illegible]

PROVISIONAL MAP
Produced from original manuscript drawings. Information shown as of date of field check. T

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
SUPPLEMENTARY CONTOUR INTERVAL 20 FEET

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225

QUADRANGLE LOCATION

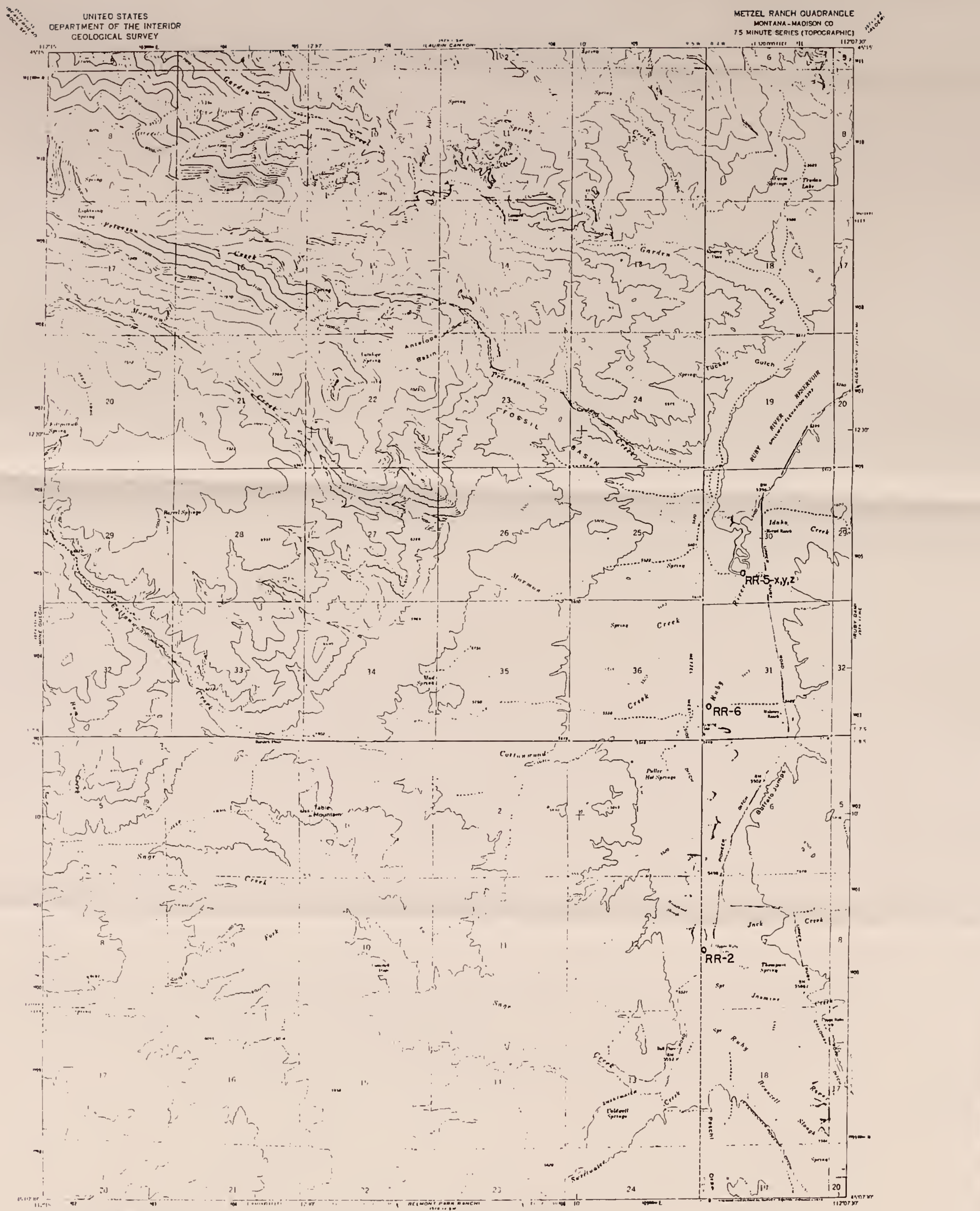
ROAD LEGEND
Improved Road
Unimproved Road
Trail
Interstate Route
U.S. Route
State Route

TWIN BRIDGES, MONTANA
PROVISIONAL EDITION 1989
45112-E3-TF-024

MISSOULA BLUEPRINT COMPANY, INC
1013 South Avenue West
Missoula, Montana 59801
Phone 549-0250

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

METZEL RANCH QUADRANGLE
MONTANA–MADISON CO
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey
as part of the Department of the Interior program
for the development of the Missouri River Basin

SCALE 1:24000

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U S GEOLOGICAL SURVEY DENVER COLORADO 80225 OR RESTON VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION
Light duty ———— Unimproved dirt ....

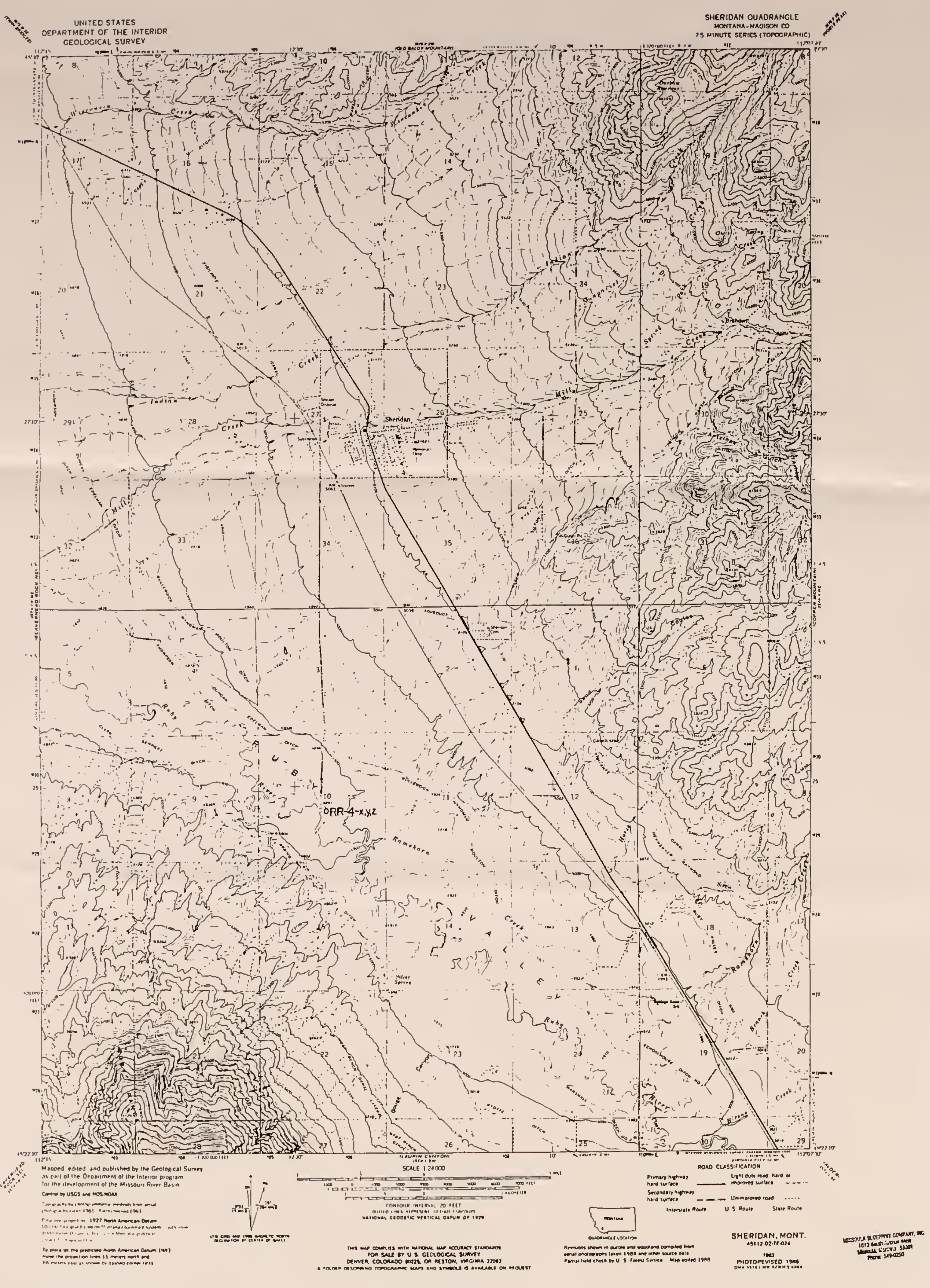
MONTANA
QUADRANGLE LOCATION

METZEL RANCH, MONT
N4507.5—W11200/7.5

1963

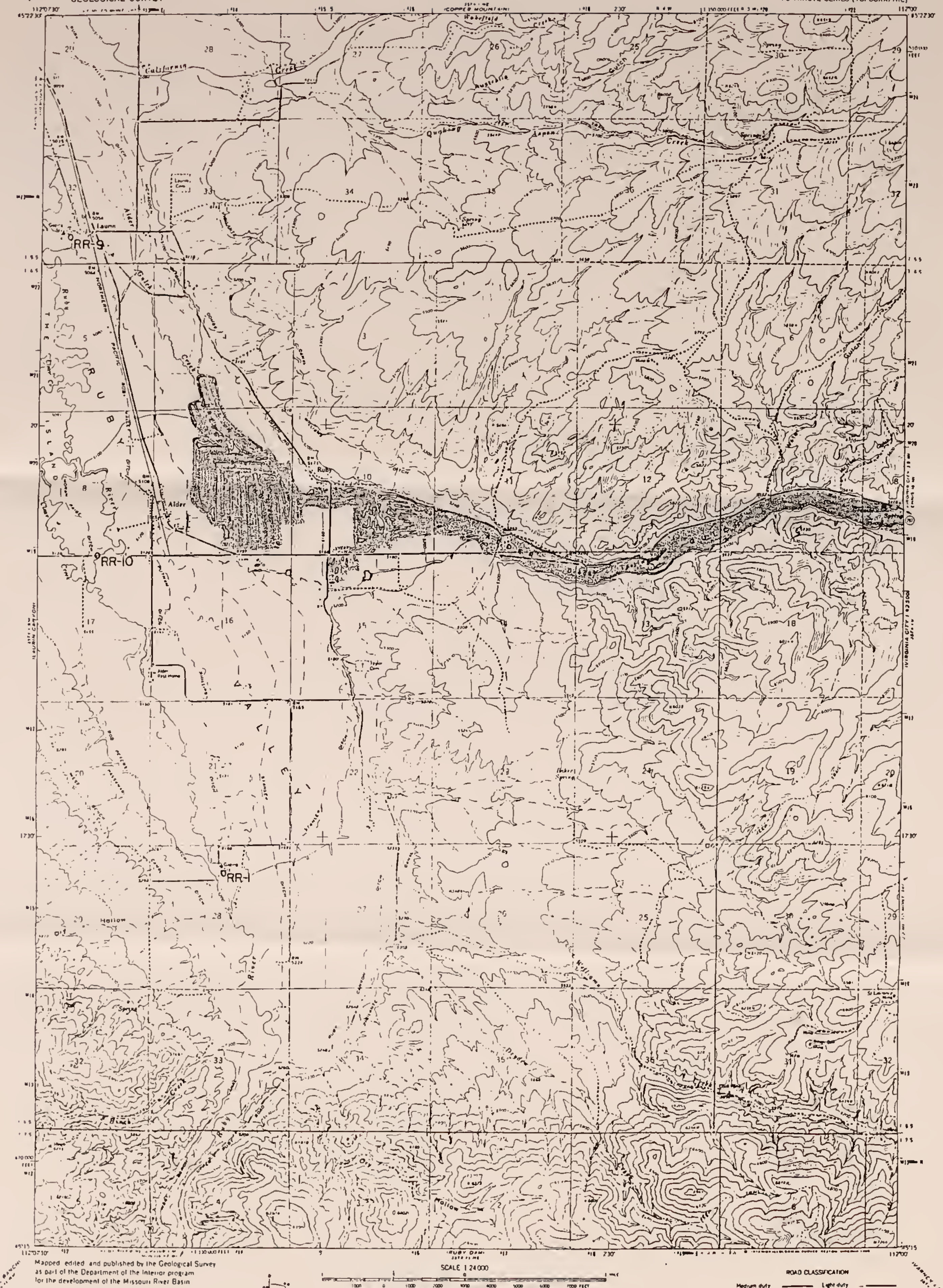
MISSOULA BLUEPRINT COMPANY

oRR-3


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
SHERIDAN QUADRANGLE
MONTANA-MADISON CO
7.5 MINUTE SERIES (TOPOGRAPHIC)
Sheridan
Ruby River
Mill Creek
Indian Creek
Ramshorn Creek
Harris Creek
Brandon
Antelope
Coyote
Wisconsin Creek
Sheridan Cem
Silver Spring
Bouse Canyon
RUBY VALLEY
oRR-4-x,y,z
(COPPER MOUNTAIN)
(BEAVERHEAD ROCK NE)
(OLD BALDY MOUNTAIN)
(LAURIN CANYON)
Mapped, edited, and published by the Geological Survey
as part of the Department of the Interior program
for the development of the Missouri River Basin
Control by USGS and NOS/NOAA
Polyconic projection. 1927 North American Datum
To place on the predicted North American Datum 1983
move the projection lines 11 meters north and
66 meters east as shown by dashed corner ticks
UTM GRID AND 1988 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET
SCALE 1:24 000
CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U S GEOLOGICAL SURVEY
DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST
ROAD CLASSIFICATION
Primary highway hard surface
Light duty road, hard or improved surface
Secondary highway hard surface
Unimproved road
Interstate Route
U S Route
State Route
MONTANA
QUADRANGLE LOCATION
Revisions shown in purple and woodland compiled from
aerial photographs taken 1984 and other source data
Partial field check by U. S. Forest Service. Map edited 1988
SHERIDAN, MONT.
45112-02-TF-024
1963
PHOTOREVISED 1988
MISSOULA BLUEPRINT COMPANY, INC.
Phone 549-0250

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

ALDER QUADRANGLE
MONTANA-MADISON CO
7.5 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey
as part of the Department of the Interior program
for the development of the Missouri River Basin

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial
photographs taken 1961. Field checked 1963

Polyconic projection. 1927 North American Datum
10,000-foot grid based on Montana coordinate system, south zone
1000-metre Universal Transverse Mercator grid ticks,
zone 12, shown in blue

Fine red dashed lines indicate selected fence lines

To place on the predicted North American Datum 1983

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U S GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ALDER, MONT.
45112-C1-TF-024
1963

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MISSOULA, MONTANA 59801
PHONE 549-0730

Appendix B

ICP Corrected Data—including QA/QC Samples

The table below provides a guide to the types of samples found in the following pages of ICP analytical results. Data for the first seven sample types—in the upper portion of the table—are corrected for both dilution and actual sample weight, method blanks assume the nominal dilution + weight correction of multiplication by 100. The remaining sample types involve no correction for dilution or sample weight. All results are in concentration units of parts per million, in the sample (first seven types) or solution (remaining types).

ICP Sample Types

Type Code	Description
S	regular sample digest
SD	sample selected for duplicate digestion
SS	sample selected for pre-digestion spiking
SD2	duplicate sample digestion
SS2	spiked sample digestion
SB	method blank
R	standard reference material
B	milli-q water
CB	calibration blank check
CC	continuing calibration check
IC	interelement interference check
O	other

CFDA Sediment Digests - Dilution & Weight Corrected Data

Analysis Report Summary Mon 02-24-92 02:07:17 PM page 1

# Sample Name	File	Method	Date	Time	OpID	Type	Mode
Std 6 composite	CFDA	CFDASED	02/24/92	10:26	dae	CC	CONC
Std 1	CFDA	CFDASED	02/24/92	10:31	dae	CB	CONC
Milli-Q Water	CFDA	CFDASED	02/24/92	10:34	dae	B	CONC
Blank	CFDA	CFDASED	02/24/92	10:37	dae	SB	CONC
BC-01	CFDA	CFDASED	02/24/92	10:40	dae	S	CONC
BC-02-X	CFDA	CFDASED	02/24/92	10:43	dae	S	CONC
BC-02-Y	CFDA	CFDASED	02/24/92	10:46	dae	S	CONC
BC-02-Z	CFDA	CFDASED	02/24/92	10:49	dae	S	CONC
BC-03	CFDA	CFDASED	02/24/92	10:52	dae	SD	CONC
BC-04	CFDA	CFDASED	02/24/92	10:55	dae	S	CONC
BC-05-X	CFDA	CFDASED	02/24/92	10:58	dae	SS	CONC
BC-05-Y	CFDA	CFDASED	02/24/92	11:01	dae	S	CONC
BC-05-Z	CFDA	CFDASED	02/24/92	11:03	dae	S	CONC
BC-06-A	CFDA	CFDASED	02/24/92	11:06	dae	S	CONC
Blank	CFDA	CFDASED	02/24/92	11:10	dae	SB	CONC
BC-06-B	CFDA	CFDASED	02/24/92	11:13	dae	S	CONC
BH-01	CFDA	CFDASED	02/24/92	11:16	dae	SD	CONC
BH-01-Y	CFDA	CFDASED	02/24/92	11:19	dae	S	CONC
BH-01-Z	CFDA	CFDASED	02/24/92	11:22	dae	S	CONC
BH-02	CFDA	CFDASED	02/24/92	11:25	dae	S	CONC
BC-03 d	CFDA	CFDASED	02/24/92	11:28	dae	SD2	CONC
BH-04-X	CFDA	CFDASED	02/24/92	11:31	dae	S	CONC
BH-03	CFDA	CFDASED	02/24/92	11:34	dae	S	CONC
BC-05-X s	CFDA	CFDASED	02/24/92	11:37	dae	SS2	CONC
USGS SED2	CFDA	CFDASED	02/24/92	11:40	dae	R	CONC
Blank	CFDA	CFDASED	02/24/92	11:44	dae	SB	CONC
STD 1 Blank	CFDA	CFDASED	02/24/92	11:47	dae	CB	CONC
STD 6 composite	CFDA	CFDASED	02/24/92	11:50	dae	CC	CONC
STD 6 composite	CFDA	CFDASED	02/24/92	11:50	dae	CC	CONC
STD 6 composite	CFDA	CFDASED	02/24/92	12:17	dae	CC	CONC
STD 1 Blank	CFDA	CFDASED	02/24/92	12:21	dae	CB	CONC
Milli-Q water	CFDA	CFDASED	02/24/92	12:24	dae	B	CONC
Blank	CFDA	CFDASED	02/24/92	12:27	dae	SB	CONC
BH-04-Y	CFDA	CFDASED	02/24/92	12:31	dae	SS	CONC
BH-04-Z	CFDA	CFDASED	02/24/92	12:33	dae	S	CONC
BH-05	CFDA	CFDASED	02/24/92	12:36	dae	S	CONC
BH-05-Y	CFDA	CFDASED	02/24/92	12:39	dae	S	CONC
BH-05-Z	CFDA	CFDASED	02/24/92	12:42	dae	S	CONC
BH-06	CFDA	CFDASED	02/24/92	12:44	dae	S	CONC
BH-07	CFDA	CFDASED	02/24/92	12:47	dae	SS	CONC
BH-08-A	CFDA	CFDASED	02/24/92	12:50	dae	SS	CONC
BH-08-B	CFDA	CFDASED	02/24/92	12:52	dae	S	CONC
BH-09	CFDA	CFDASED	02/24/92	12:55	dae	S	CONC
Blank	CFDA	CFDASED	02/24/92	12:58	dae	SB	CONC
BH-10	CFDA	CFDASED	02/24/92	13:01	dae	S	CONC
BH-11	CFDA	CFDASED	02/24/92	13:03	dae	S	CONC

CFDA Sediment Digests - Dilution & Weight Corrected Data

Analysis Report Summary Mon 02-24-92 02:07:17 PM page 2

Sample Name	File	Method	Date	Time	OpID	Type	Mode
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FC-01-Y	CFDA	CFDASED	02/24/92	13:12	dae	S	CONC
FC-01-Z	CFDA	CFDASED	02/24/92	13:14	dae	S	CONC
FC-02	CFDA	CFDASED	02/24/92	13:18	dae	S	CONC
BH-04-Y s	CFDA	CFDASED	02/24/92	13:21	dae	SS2	CONC
USGS SED2	CFDA	CFDASED	02/24/92	13:24	dae	R	CONC
BH-01 d	CFDA	CFDASED	02/24/92	13:26	dae	SD2	CONC
Blank	CFDA	CFDASED	02/24/92	13:29	dae	SB	CONC
STD 1 Blank	CFDA	CFDASED	02/24/92	13:32	dae	CB	CONC
STD 6 composite	CFDA	CFDASED	02/24/92	13:34	dae	CC	CONC
10% HCl Blank	CFDA	CFDASED	02/24/92	13:39	dae	CB	CONC
ICS Sol A	CFDA	CFDASED	02/24/92	13:41	dae	IC	CONC
ICS Sol AB	CFDA	CFDASED	02/24/92	13:44	dae	IC	CONC
10% HCl Blank	CFDA	CFDASED	02/24/92	13:48	dae	CB	CONC
Milli-Q H2O	CFDA	CFDASED	02/24/92	13:50	dae	B	CONC
1000 ppm P	CFDA	CFDASED	02/24/92	13:59	dae	O	CONC

CFDA Sediment Digests - Dilution & Weight Corrected Data

Analysis Report Summary Fri 02-28-92 03:19:00 PM page 1

# Sample Name	File	Method	Date	Time	OpID	Type	Mode
STD 6 composite	CFDA	CFDASED	02/28/92	10:42	dae	CC	CONC
STD 1 Blank	CFDA	CFDASED	02/28/92	10:44	dae	CB	CONC
Milli-Q Water	CFDA	CFDASED	02/28/92	10:47	dae	B	CONC
Blank	CFDA	CFDASED	02/28/92	10:51	dae	SB	CONC
FC-03	CFDA	CFDASED	02/28/92	10:54	dae	S	CONC
FC-03-Y	CFDA	CFDASED	02/28/92	10:57	dae	S	CONC
FC-03-Z	CFDA	CFDASED	02/28/92	10:59	dae	S	CONC
GC-01	CFDA	CFDASED	02/28/92	11:02	dae	S	CONC
GC-02-X	CFDA	CFDASED	02/28/92	11:05	dae	S	CONC
GC-02-Y	CFDA	CFDASED	02/28/92	11:08	dae	S	CONC
GC-02-Z	CFDA	CFDASED	02/28/92	11:10	dae	SD	CONC
GC-03	CFDA	CFDASED	02/28/92	11:13	dae	S	CONC
LB-01	CFDA	CFDASED	02/28/92	11:15	dae	S	CONC
LB-02-X	CFDA	CFDASED	02/28/92	11:18	dae	S	CONC
Blank	CFDA	CFDASED	02/28/92	11:21	dae	SB	CONC
LB-02-Y	CFDA	CFDASED	02/28/92	11:24	dae	S	CONC
LB-02-Z	CFDA	CFDASED	02/28/92	11:28	dae	S	CONC
LB-03	CFDA	CFDASED	02/28/92	11:31	dae	SS	CONC
LB-03 again	CFDA	CFDASED	02/28/92	11:34	dae	SS	CONC
RC-01	CFDA	CFDASED	02/28/92	11:37	dae	S	CONC
RC-01-Y	CFDA	CFDASED	02/28/92	11:40	dae	S	CONC
RC-01-Z	CFDA	CFDASED	02/28/92	11:43	dae	S	CONC
RC-02	CFDA	CFDASED	02/28/92	11:46	dae	S	CONC
GC-02-Z d	CFDA	CFDASED	02/28/92	11:51	dae	SD2	CONC
BH-07 s	CFDA	CFDASED	02/28/92	11:53	dae	SS2	CONC
USGS SED2	CFDA	CFDASED	02/28/92	11:57	dae	R	CONC
Blank	CFDA	CFDASED	02/28/92	11:59	dae	SB	CONC
STD 1 Blank	CFDA	CFDASED	02/28/92	12:03	dae	CB	CONC
STD 6 composite	CFDA	CFDASED	02/28/92	12:05	dae	CC	CONC
ICS Sol A	CFDA	CFDASED	02/28/92	12:10	dae	IC	CONC
ICS Sol AB	CFDA	CFDASED	02/28/92	12:13	dae	IC	CONC
STD 1 Blank	CFDA	CFDASED	02/28/92	12:16	dae	CB	CONC
STD 6 composite	CFDA	CFDASED	02/28/92	12:30	dae	CC	CONC
STD 1 Blank	CFDA	CFDASED	02/28/92	12:33	dae	CB	CONC
Milli-Q Water	CFDA	CFDASED	02/28/92	12:36	dae	B	CONC
Blank	CFDA	CFDASED	02/28/92	12:39	dae	SB	CONC
RC-02-Y	CFDA	CFDASED	02/28/92	12:42	dae	S	CONC
RC-02-Z	CFDA	CFDASED	02/28/92	12:45	dae	S	CONC
RC-03	CFDA	CFDASED	02/28/92	12:48	dae	S	CONC
RC-03-Y	CFDA	CFDASED	02/28/92	12:50	dae	S	CONC
RC-03-Z	CFDA	CFDASED	02/28/92	12:53	dae	S	CONC
RC-04	CFDA	CFDASED	02/28/92	12:56	dae	S	CONC
RC-05	CFDA	CFDASED	02/28/92	12:58	dae	S	CONC
RC-06	CFDA	CFDASED	02/28/92	13:01	dae	S	CONC
RR-01	CFDA	CFDASED	02/28/92	13:03	dae	S	CONC
RR-02	CFDA	CFDASED	02/28/92	13:06	dae	S	CONC

CFDA Sediment Digests - Dilution & Weight Corrected Data

```
Analysis Report      Summary          Fri 02-28-92           03:19:00 PM     page 2

Sample Name               File      Method     Date              Time    OpID    Type    Mode
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Blank                     CFDA      CFDASED        02/28/92      13:09   dae     SB      CONC
RR-03                     CFDA      CFDASED        02/28/92      13:12   dae     S       CONC
RR-04-X                   CFDA      CFDASED        02/28/92      13:15   dae     S       CONC
RR-04-Y                   CFDA      CFDASED        02/28/92      13:18   dae     S       CONC
RR-04-Z                   CFDA      CFDASED        02/28/92      13:21   dae     S       CONC
RR-05-X                   CFDA      CFDASED        02/28/92      13:24   dae     S       CONC
RR-05-Y                   CFDA      CFDASED        02/28/92      13:27   dae     S       CONC
RR-05-Z                   CFDA      CFDASED        02/28/92      13:29   dae     S       CONC
RR-09 d                   CFDA      CFDASED        02/28/92      13:32   dae     SD2     CONC
BH-08-A s                 CFDA      CFDASED        02/28/92      13:35   dae     SS2     CONC
USGS SED2                 CFDA      CFDASED        02/28/92      13:38   dae     R       CONC
Blank                     CFDA      CFDASED        02/28/92      13:41   dae     SB      CONC
STD 1 Blank               CFDA      CFDASED        02/28/92      13:44   dae     CB      CONC
STD 6 composite           CFDA      CFDASED        02/28/92      13:46   dae     CC      CONC
Milli-Q water             CFDA      CFDASED        02/28/92      13:49   dae     B       CONC
Blank                     CFDA      CFDASED        02/28/92      13:52   dae     SB      CONC
RR-06                     CFDA      CFDASED        02/28/92      13:55   dae     S       CONC
RR-07                     CFDA      CFDASED        02/28/92      13:58   dae     SS      CONC
RR-08                     CFDA      CFDASED        02/28/92      14:00   dae     S       CONC
RR-09                     CFDA      CFDASED        02/28/92      14:03   dae     SD      CONC
RR-10                     CFDA      CFDASED        02/28/92      14:05   dae     S       CONC
CF-55-A                   CFDA      CFDASED        02/28/92      14:08   dae     S       CONC
CF-55-B                   CFDA      CFDASED        02/28/92      14:11   dae     S       CONC
CF-01-X                   CFDA      CFDASED        02/28/92      14:13   dae     SD      CONC
CF-01-Y                   CFDA      CFDASED        02/28/92      14:16   dae     S       CONC
CF-01-Z                   CFDA      CFDASED        02/28/92      14:18   dae     S       CONC
Blank                     CFDA      CFDASED        02/28/92      14:24   dae     SB      CONC
CF-02                     CFDA      CFDASED        02/28/92      14:27   dae     S       CONC
CF-03-A                   CFDA      CFDASED        02/28/92      14:30   dae     SD      CONC
CF-03-B                   CFDA      CFDASED        02/28/92      14:32   dae     S       CONC
CF-34                     CFDA      CFDASED        02/28/92      14:34   dae     S       CONC
CF-04                     CFDA      CFDASED        02/28/92      14:37   dae     S       CONC
CF-33                     CFDA      CFDASED        02/28/92      14:39   dae     S       CONC
CF-32                     CFDA      CFDASED        02/28/92      14:42   dae     S       CONC
CF-01-X d                 CFDA      CFDASED        02/28/92      14:44   dae     SD2     CONC
LB-03 s                   CFDA      CFDASED        02/28/92      14:47   dae     SS2     CONC
USGS SED2                 CFDA      CFDASED        02/28/92      14:50   dae     R       CONC
Blank                     CFDA      CFDASED        02/28/92      14:54   dae     SB      CONC
Blank again               CFDA      CFDASED        02/28/92      14:56   dae     SB      CONC
STD 1 Blank               CFDA      CFDASED        02/28/92      14:58   dae     CB      CONC
STD 6 composite           CFDA      CFDASED        02/28/92      15:01   dae     CC      CONC
STD 2                     CFDA      CFDASED        02/28/92      15:04   dae     CC      CONC
STD 3                     CFDA      CFDASED        02/28/92      15:06   dae     CC      CONC
STD 4                     CFDA      CFDASED        02/28/92      15:08   dae     CC      CONC
STD 2 again               CFDA      CFDASED        02/28/92      15:11   dae     CC      CONC
```

CFDA Sediment Digests - Dilution & Weight Corrected Data

Analysis Report Summary Fri 03-20-92 03:31:33 PM page 1

# Sample Name	File	Method	Date	Time	OpID	Type	Mode
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Std. 1 10% HCl Blank	CFDA	CFDASED	03/20/92	10:25	dae	CB	CONC
Milli-Q water	CFDA	CFDASED	03/20/92	10:28	dae	B	CONC
Blank	CFDA	CFDASED	03/20/92	10:32	dae	SB	CONC
CF-31	CFDA	CFDASED	03/20/92	10:36	dae	S	CONC
CF-05	CFDA	CFDASED	03/20/92	10:38	dae	S	CONC
CF-06	CFDA	CFDASED	03/20/92	10:42	dae	S	CONC
CF-06-Y	CFDA	CFDASED	03/20/92	10:45	dae	S	CONC
CF-06-Z	CFDA	CFDASED	03/20/92	10:48	dae	S	CONC
CF-07	CFDA	CFDASED	03/20/92	10:51	dae	S	CONC
CF-54	CFDA	CFDASED	03/20/92	10:54	dae	S	CONC
CF-08	CFDA	CFDASED	03/20/92	10:57	dae	S	CONC
CF-09	CFDA	CFDASED	03/20/92	11:01	dae	S	CONC
CF-10	CFDA	CFDASED	03/20/92	11:04	dae	S	CONC
Blank	CFDA	CFDASED	03/20/92	11:07	dae	SB	CONC
CF-13-X	CFDA	CFDASED	03/20/92	11:10	dae	S	CONC
CF-13-Y	CFDA	CFDASED	03/20/92	11:13	dae	S	CONC
CF-13-Z	CFDA	CFDASED	03/20/92	11:15	dae	S	CONC
CF-14	CFDA	CFDASED	03/20/92	11:18	dae	S	CONC
CF-11	CFDA	CFDASED	03/20/92	11:22	dae	SD	CONC
CF-35	CFDA	CFDASED	03/20/92	11:24	dae	SS	CONC
CF-15	CFDA	CFDASED	03/20/92	11:27	dae	S	CONC
CF-03-A d	CFDA	CFDASED	03/20/92	11:30	dae	SD2	CONC
RR-07 s	CFDA	CFDASED	03/20/92	11:34	dae	SS2	CONC
USGS SED2	CFDA	CFDASED	03/20/92	11:37	dae	R	CONC
Blank	CFDA	CFDASED	03/20/92	11:40	dae	SB	CONC
Blank	CFDA	CFDASED	03/20/92	11:44	dae	SB	CONC
Std 1 Blank	CFDA	CFDASED	03/20/92	11:48	dae	CB	CONC
Std 6 composite	CFDA	CFDASED	03/20/92	11:51	dae	CC	CONC
Std 6 composite	CFDA	CFDASED	03/20/92	12:21	dae	CC	CONC
Std 1 Blank	CFDA	CFDASED	03/20/92	12:24	dae	CB	CONC
Milli-Q water	CFDA	CFDASED	03/20/92	12:27	dae	B	CONC
Blank	CFDA	CFDASED	03/20/92	12:29	dae	SB	CONC
Blank	CFDA	CFDASED	03/20/92	12:32	dae	SB	CONC
CF-15-Y	CFDA	CFDASED	03/20/92	12:35	dae	S	CONC
CF-15-Z	CFDA	CFDASED	03/20/92	12:38	dae	S	CONC
CF-36	CFDA	CFDASED	03/20/92	12:41	dae	SD	CONC
CF-37	CFDA	CFDASED	03/20/92	12:43	dae	S	CONC
CF-12	CFDA	CFDASED	03/20/92	12:46	dae	S	CONC
CF-21	CFDA	CFDASED	03/20/92	12:48	dae	S	CONC
CF-22-X	CFDA	CFDASED	03/20/92	12:51	dae	SS	CONC
CF-22-Y	CFDA	CFDASED	03/20/92	12:53	dae	S	CONC
CF-22-Z	CFDA	CFDASED	03/20/92	12:56	dae	S	CONC
CF-53	CFDA	CFDASED	03/20/92	12:59	dae	S	CONC
Blank	CFDA	CFDASED	03/20/92	13:03	dae	SB	CONC
CF-20	CFDA	CFDASED	03/20/92	13:05	dae	S	CONC

CFDA Sediment Digests - Dilution & Weight Corrected Data

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Analysis Report     Summary          Fri 03-20-92          03:31:33 PM     page 2

Sample Name          File      Method      Date              Time    OpID   Type   Mode
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CF-38                CFDA      CFDASED        03/20/92       13:09   dae    S      CONC
CF-39                CFDA      CFDASED        03/20/92       13:11   dae    S      CONC
CF-40                CFDA      CFDASED        03/20/92       13:14   dae    S      CONC
CF-41                CFDA      CFDASED        03/20/92       13:16   dae    S      CONC
CF-19                CFDA      CFDASED        03/20/92       13:19   dae    S      CONC
CF-18-A              CFDA      CFDASED        03/20/92       13:21   dae    S      CONC
CF-11 d              CFDA      CFDASED        03/20/92       13:24   dae    SD2    CONC
CF-35 s              CFDA      CFDASED        03/20/92       13:27   dae    SS2    CONC
USGS SED2            CFDA      CFDASED        03/20/92       13:29   dae    R      CONC
Blank                CFDA      CFDASED        03/20/92       13:33   dae    SB     CONC
Std 1 Blank          CFDA      CFDASED        03/20/92       13:36   dae    CB     CONC
Std 6 composite      CFDA      CFDASED        03/20/92       13:39   dae    CC     CONC
Milli-Q water        CFDA      CFDASED        03/20/92       13:44   dae    B      CONC
 Blank               CFDA      CFDASED        03/20/92       13:46   dae    SB     CONC
CF-18-B              CFDA      CFDASED        03/20/92       13:49   dae    S      CONC
CF-52-X              CFDA      CFDASED        03/20/92       13:52   dae    S      CONC
CF-52-Y              CFDA      CFDASED        03/20/92       13:55   dae    S      CONC
CF-52-Z              CFDA      CFDASED        03/20/92       13:57   dae    S      CONC
CF-17                CFDA      CFDASED        03/20/92       13:59   dae    S      CONC
CF-42                CFDA      CFDASED        03/20/92       14:02   dae    S      CONC
CF-43                CFDA      CFDASED        03/20/92       14:05   dae    SS     CONC
CF-44                CFDA      CFDASED        03/20/92       14:08   dae    S      CONC
CF-45                CFDA      CFDASED        03/20/92       14:11   dae    S      CONC
 Blank               CFDA      CFDASED        03/20/92       14:14   dae    SB     CONC
CF-16                CFDA      CFDASED        03/20/92       14:17   dae    S      CONC
CF-46-A              CFDA      CFDASED        03/20/92       14:20   dae    S      CONC
CF-46-B              CFDA      CFDASED        03/20/92       14:23   dae    S      CONC
CF-23                CFDA      CFDASED        03/20/92       14:26   dae    S      CONC
CF-47                CFDA      CFDASED        03/20/92       14:29   dae    S      CONC
CF-23                CFDA      CFDASED        03/20/92       14:34   dae    S      CONC
CF-25                CFDA      CFDASED        03/20/92       14:37   dae    S      CONC
CF-24                CFDA      CFDASED        03/20/92       14:40   dae    S      CONC
CF-51                CFDA      CFDASED        03/20/92       14:42   dae    S      CONC
CF-36 d              CFDA      CFDASED        03/20/92       14:45   dae    SD2    CONC
CF-22-X s            CFDA      CFDASED        03/20/92       14:48   dae    SS2    CONC
USGS SED2            CFDA      CFDASED        03/20/92       14:50   dae    R      CONC
 Blank               CFDA      CFDASED        03/20/92       14:53   dae    SB     CONC
 Blank               CFDA      CFDASED        03/20/92       14:55   dae    SB     CONC
Std 1 Blank          CFDA      CFDASED        03/20/92       14:58   dae    CB     CONC
Std 6 composite      CFDA      CFDASED        03/20/92       15:00   dae    CC     CONC
ICS Sol A            CFDA      CFDASED        03/20/92       15:11   dae    IC     CONC
ICS Sol AB           CFDA      CFDASED        03/20/92       15:14   dae    IC     CONC
Std 2                CFDA      CFDASED        03/20/92       15:16   dae    CC     CONC
Std 3                CFDA      CFDASED        03/20/92       15:19   dae    CC     CONC
Std 4                CFDA      CFDASED        03/20/92       15:21   dae    CC     CONC
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CFDA Sediment Digests - Dilution & Weight Corrected Data

Analysis Report Summary Thu 03-26-92 02:50:13 PM page 1

Sample Name	File	Method	Date	Time	OpID	Type	Mode
Std 6 composite	CFDA	CFDASED	03/26/92	11:00	dae	CC	CONC
Std 1 Blank	CFDA	CFDASED	03/26/92	11:03	dae	CB	CONC
Milli-Q water	CFDA	CFDASED	03/26/92	11:06	dae	B	CONC
Blank	CFDA	CFDASED	03/26/92	11:09	dae	SB	CONC
CF-27	CFDA	CFDASED	03/26/92	11:12	dae	S	CONC
CF-48A	CFDA	CFDASED	03/26/92	11:16	dae	S	CONC
CF-48B	CFDA	CFDASED	03/26/92	11:19	dae	S	CONC
CF-26	CFDA	CFDASED	03/26/92	11:22	dae	S	CONC
CF-49-Y	CFDA	CFDASED	03/26/92	11:24	dae	S	CONC
CF-49-Z	CFDA	CFDASED	03/26/92	11:27	dae	S	CONC
CF-28	CFDA	CFDASED	03/26/92	11:30	dae	S	CONC
CF-30	CFDA	CFDASED	03/26/92	11:32	dae	SS	CONC
CF-50-X	CFDA	CFDASED	03/26/92	11:35	dae	S	CONC
CF-50-Y	CFDA	CFDASED	03/26/92	11:38	dae	S	CONC
Blank	CFDA	CFDASED	03/26/92	11:43	dae	SB	CONC
CF-50-Z	CFDA	CFDASED	03/26/92	11:46	dae	S	CONC
CF-29	CFDA	CFDASED	03/26/92	11:50	dae	S	CONC
SB-01	CFDA	CFDASED	03/26/92	11:54	dae	S	CONC
CF-29 1:2 Dil.	CFDA	CFDASED	03/26/92	11:58	dae	DIL	CONC
SB-01-Y	CFDA	CFDASED	03/26/92	12:02	dae	S	CONC
SB-01-Z	CFDA	CFDASED	03/26/92	12:04	dae	S	CONC
SB-02-A	CFDA	CFDASED	03/26/92	12:09	dae	S	CONC
SB-02-B	CFDA	CFDASED	03/26/92	12:11	dae	S	CONC
SB-03-Y d	CFDA	CFDASED	03/26/92	12:15	dae	SD2	CONC
CF-43 s	CFDA	CFDASED	03/26/92	12:18	dae	SS2	CONC
USGS SED2	CFDA	CFDASED	03/26/92	12:21	dae	R	CONC
Blank	CFDA	CFDASED	03/26/92	12:25	dae	SB	CONC
Blank	CFDA	CFDASED	03/26/92	12:28	dae	SB	CONC
Std 1 Blank	CFDA	CFDASED	03/26/92	12:32	dae	CB	CONC
Std 6 composite	CFDA	CFDASED	03/26/92	12:35	dae	CC	CONC
ICS Sol A	CFDA	CFDASED	03/26/92	12:39	dae	IC	CONC
ICS Sol AB	CFDA	CFDASED	03/26/92	12:41	dae	IC	CONC
Std 6 composite	CFDA	CFDASED	03/26/92	12:48	dae	CC	CONC
Std 1 Blank	CFDA	CFDASED	03/26/92	12:51	dae	CB	CONC
Milli-Q water	CFDA	CFDASED	03/26/92	12:54	dae	B	CONC
Blank	CFDA	CFDASED	03/26/92	12:57	dae	SB	CONC
SB-03-X	CFDA	CFDASED	03/26/92	13:01	dae	S	CONC
SB-03-Y	CFDA	CFDASED	03/26/92	13:04	dae	SD	CONC
SB-03-Z	CFDA	CFDASED	03/26/92	13:06	dae	S	CONC
SB-04	CFDA	CFDASED	03/26/92	13:09	dae	S	CONC
SB-05-Y	CFDA	CFDASED	03/26/92	13:14	dae	S	CONC
SB-05-Z	CFDA	CFDASED	03/26/92	13:16	dae	S	CONC
SB-06-X	CFDA	CFDASED	03/26/92	13:21	dae	S	CONC
SB-06-Y	CFDA	CFDASED	03/26/92	13:23	dae	S	CONC
SB-06-Z	CFDA	CFDASED	03/26/92	13:26	dae	S	CONC
SB-07	CFDA	CFDASED	03/26/92	13:29	dae	S	CONC

CFDA Sediment Digests - Dilution & Weight Corrected Data

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Analysis Report      Summary          Thu 03-26-92                02:50:13  PM      page 2

Sample Name           File     Method       Date          Time     OpID    Type    Mode
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 Blank                CFDA     CFDASED      03/26/92      13:32     dae     SB      CONC
SB-05-Y               CFDA     CFDASED      03/26/92      13:35     dae     S       CONC
SB-05-Z               CFDA     CFDASED      03/26/92      13:38     dae     S       CONC
SB-06-X               CFDA     CFDASED      03/26/92      13:40     dae     S       CONC
SB-08                 CFDA     CFDASED      03/26/92      13:44     dae     S       CONC
SB-09                 CFDA     CFDASED      03/26/92      13:46     dae     S       CONC
SB-10                 CFDA     CFDASED      03/26/92      13:49     dae     S       CONC
SB-11                 CFDA     CFDASED      03/26/92      13:51     dae     S       CONC
SB-12                 CFDA     CFDASED      03/26/92      13:54     dae     S       CONC
SB-13-A               CFDA     CFDASED      03/26/92      13:57     dae     S       CONC
SB-13-B               CFDA     CFDASED      03/26/92      13:59     dae     SD      CONC
SB-13-B  d            CFDA     CFDASED      03/26/92      14:01     dae     SD2     CONC
CF-30 s               CFDA     CFDASED      03/26/92      14:05     dae     SS2     CONC
USGS SED2             CFDA     CFDASED      03/26/92      14:07     dae     R       CONC
 Blank                CFDA     CFDASED      03/26/92      14:12     dae     SB      CONC
Std 1 Blank           CFDA     CFDASED      03/26/92      14:17     dae     CB      CONC
Std 6 composite       CFDA     CFDASED      03/26/92      14:20     dae     CC      CONC
Std 2                 CFDA     CFDASED      03/26/92      14:23     dae     CC      CONC
Std 2                 CFDA     CFDASED      03/26/92      14:26     dae     CC      CONC
Std 3                 CFDA     CFDASED      03/26/92      14:28     dae     CC      CONC
Std 4                 CFDA     CFDASED      03/26/92      14:31     dae     CC      CONC
ICS Sol A             CFDA     CFDASED      03/26/92      14:33     dae     IC      CONC
ICS Sol AB            CFDA     CFDASED      03/26/92      14:36     dae     IC      CONC
Milli-Q water         CFDA     CFDASED      03/26/92      14:40     dae     B       CONC
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CFDA Sediment Digests - Dilution & Weight Corrected Data

Analysis Report Averages Mon 02-24-92 02:07:17 PM page 1

# Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
Std 6 composite	2.04	1.99	20.6	2.05	2.04	2.01	20.20
Std 1	-0.014	0.013	-0.008	0.0012	-0.0008	-0.001	-0.00
Milli-Q Water	-0.025	0.03	-0.011	0.0016	-0.0024	-0.036	0.01
Blank	-1.6	0.4	0.2	0.2	-0.2	-2.3	-0.1
BC-01	13231.7	50.5	10224.5	-0.1	87.9	30372.7	5593.4
BC-02-X	14900.0	49.0	9700.0	0.5	101.0	29100.0	5870.0
BC-02-Y	15363.0	55.5	10275.3	0.6	104.2	31524.2	6085.4
BC-02-Z	14069.0	90.5	9519.0	-0.1	92.8	39413.1	5687.5
BC-03	12402.5	84.6	9752.0	0.3	113.6	39607.9	5331.1
BC-04	12092.7	119.9	8065.2	1.2	114.0	37877.3	4557.3
BC-05-X	12807.7	60.0	8285.0	1.0	138.1	31919.1	5213.1
BC-05-Y	12579.8	55.2	7977.2	0.9	134.8	31849.0	5171.7
BC-05-Z	13397.3	75.5	8388.3	0.6	122.7	37392.5	5288.9
BC-06-A	15036.0	158.4	6956.7	0.6	121.7	49919.5	3919.4
Blank	-0.4	0.2	1.1	0.1	-0.1	8.7	-0.1
BC-06-B	14379.8	162.8	7100.0	0.4	123.9	49730.3	3934.5
BH-01	10300.0	24.1	11200.0	0.6	39.2	24900.0	5400.0
BH-01-Y	9995.9	43.6	11329.4	0.5	32.7	26067.6	5113.3
BH-01-Z	10199.0	48.5	11511.7	0.6	36.0	27870.5	5180.3
BH-02	12095.2	19.9	8606.6	0.6	41.4	20591.8	5927.6
BC-03 d	12902.6	85.7	10102.0	0.3	114.9	41308.3	5391.1
BH-04-X	6641.3	20.6	13402.7	0.3	21.7	18003.6	3740.7
BH-03	9788.0	28.8	8888.2	0.9	48.9	20295.9	4779.0
BC-05-X s	12354.1	165.7	8457.0	12.2	247.7	32241.2	5162.6
USGS SED2	6231.2	162.0	17803.6	7.3	1166.2	22004.4	4680.9
Blank	-2.5	-1.4	1.4	0.2	1.4	-0.4	1.1
STD 1 Blank	0.01	-0.01	-0.00	0.00	0.01	0.01	0.01
STD 6 composite	2.09	2.03	21.60	2.12	2.11	2.17	20.60
STD 6 composite	2.00	1.95	19.90	2.00	1.99	1.97	19.80
STD 6 composite	2.02	2.02	20.40	2.04	2.01	2.00	19.90
STD 1 Blank	-0.02	0.01	0.00	0.00	0.00	-0.01	0.01
Milli-Q water	-0.03	0.01	-0.01	-0.00	-0.00	-0.04	-0.00
Blank	-2.9	-0.8	1.6	-0.1	-0.1	-3.1	-0.1
BH-04-Y	10804.3	15.5	9273.7	0.3	36.0	21208.5	5362.1
BH-04-Z	11304.5	19.2	9263.7	0.3	32.9	22108.8	5542.2
BH-05	11809.4	18.9	7866.3	0.2	30.0	18715.0	5324.3
BH-05-Y	12104.8	17.9	7853.1	0.1	32.5	17306.9	5312.1
BH-05-Z	10847.5	14.8	8205.9	0.1	30.0	17376.1	5052.1
BH-06	6569.7	26.2	15646.8	-0.1	20.1	17853.4	4122.3
BH-07	10495.8	27.3	9026.4	0.6	37.8	24490.2	4588.2
BH-08-A	9630.7	36.9	11776.4	0.2	33.2	27245.4	4760.5
BH-08-B	10091.9	38.3	11690.6	0.2	33.5	27677.8	4866.1
BH-09	9967.9	34.5	14926.8	-0.0	26.9	23241.8	5369.6
Blank	1.6	-1.2	4.3	-0.0	-0.1	1.3	1.8
BH-10	8088.4	13.8	52289.5	0.1	22.3	14497.1	11797.6
BH-11	9170.0	20.3	15200.0	-0.2	23.9	24200.0	5580.0

CFDA Sediment Digests - Dilution & Weight Corrected Data

Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
BH-12	9406.2	23.2	7197.1	-0.1	25.2	21191.5	4338.3
FC-01-X	7875.3	138.9	20387.8	1.4	58.6	12992.2	5316.8
FC-01-Y	9081.8	147.0	22204.4	1.4	63.5	14502.9	5661.1
FC-01-Z	7996.0	140.3	18637.2	1.2	56.4	13026.0	5300.6
FC-02	7072.9	197.8	28671.3	1.7	64.8	11988.0	5674.3
BH-04-Y s	11395.4	121.0	9386.2	11.0	139.7	22191.1	5497.8
USGS SED2	6828.6	157.0	17096.6	7.1	1134.8	22095.6	4839.0
BH-01 d	9740.3	26.5	10689.3	0.4	38.9	23476.5	5114.9
Blank	-0.3	-1.1	4.5	-0.1	0.6	3.4	1.5
STD 1 Blank	-0.02	0.00	0.00	-0.00	0.01	-0.01	0.02
STD 6 composite	2.01	1.99	20.30	2.03	2.01	2.01	19.70
10% HCl Blank	0.00	-0.01	-0.00	-0.00	-0.00	-0.01	0.01
ICS Sol A	209.00	-0.02	502.00	-0.00	0.01	95.00	523.00
ICS Sol AB	208.00	1.02	497.00	0.52	1.02	94.40	521.00
10% HCl Blank	0.01	-0.01	0.01	0.00	0.00	-0.01	0.03
Milli-Q H2O	-0.02	-0.01	-0.00	-0.00	-0.00	-0.04	0.01
1000 ppm P	0.01	0.02	0.00	-0.00	0.00	-0.03	0.01

CFDA Sediment Digests - Dilution & Weight Corrected Data

Analysis Report Averages Fri 02-28-92 03:19:00 PM page 1

# Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
STD 6 composite	2.04	1.98	20.50	2.04	2.01	1.99	19.90
STD 1 Blank	-0.01	-0.00	0.00	0.00	-0.00	-0.01	-0.00
Milli-Q Water	-0.03	-0.01	-0.00	0.00	-0.00	-0.02	-0.01
Blank	-2.5	-2.1	0.2	0.0	-0.1	-0.3	-1.0
FC-03	8550.2	284.3	18422.1	2.8	83.8	14016.8	6167.4
FC-03-Y	9975.2	171.7	15643.3	2.7	76.0	15237.0	5312.6
FC-03-Z	9162.7	175.9	15787.4	2.3	69.4	14088.7	5085.9
GC-01	13800.0	4.0	11800.0	0.2	30.0	17000.0	6550.0
GC-02-X	11676.6	5.1	17917.5	0.4	26.3	15401.0	5143.7
GC-02-Y	10742.0	4.0	18443.9	0.3	26.3	14390.3	4945.4
GC-02-Z	11333.9	5.4	18094.4	0.4	26.5	15012.4	5080.4
GC-03	11248.0	5.4	18414.9	0.1	26.9	14234.2	4728.2
LB-01	9157.7	20.3	18514.4	0.7	45.7	15727.3	4777.9
LB-02-X	10702.1	25.1	14102.8	0.3	67.1	19703.9	5601.1
Blank	1.5	-2.2	1.9	0.1	-0.1	2.3	-0.2
LB-02-Y	9618.1	26.7	12797.4	0.7	72.1	17696.5	5149.0
LB-02-Z	10108.1	27.3	13310.6	0.7	74.2	18114.5	5244.2
LB-03	8434.9	28.8	12392.6	0.9	52.1	15590.6	4367.4
LB-03 again	8424.9	27.3	12492.5	0.8	52.0	15590.6	4357.4
RC-01	6534.8	7.7	5975.2	-0.1	9.6	11291.0	3547.2
RC-01-Y	9871.8	6.6	6357.6	-0.2	15.2	14217.0	5406.5
RC-01-Z	10808.6	7.5	6825.5	-0.4	16.8	15312.2	5984.8
RC-02	6762.7	5.4	5592.2	-0.1	10.5	11304.5	3951.6
GC-02-Z d	11291.0	4.4	18185.4	0.2	26.3	14988.0	5046.0
BH-07 s	11293.2	127.9	9394.4	11.3	142.6	25984.4	4777.1
USGS SED2	6595.4	156.8	17695.0	7.2	1141.1	22018.3	4775.7
Blank	0.2	-1.7	3.2	0.2	0.6	3.8	-0.1
STD 1 Blank	-0.02	-0.03	0.00	0.00	0.00	0.00	-0.00
STD 6 composite	2.00	1.98	20.90	2.03	2.00	2.06	19.60
ICS Sol A	207.00	-0.08	503.00	-0.00	0.01	94.90	514.00
ICS Sol AB	205.00	0.96	502.00	0.52	1.01	94.60	511.00
STD 1 Blank	0.01	-0.01	0.02	0.00	0.00	0.01	0.02
STD 6 composite	2.03	2.01	20.30	2.03	2.00	2.00	19.80
STD 1 Blank	-0.01	0.02	0.01	-0.00	-0.00	-0.00	0.02
Milli-Q Water	-0.01	0.02	0.00	-0.00	-0.01	-0.02	0.01
Blank	-1.4	2.0	1.9	-0.0	-0.6	-0.8	1.0
RC-02-Y	7675.4	9.5	5746.6	-0.4	11.4	11892.9	4497.3
RC-02-Z	8436.6	12.2	6927.2	-0.3	12.4	13394.6	4608.2
RC-03	5928.3	9.3	6859.6	-0.3	9.5	9913.9	3434.8
RC-03-Y	6460.0	7.0	5780.0	-0.2	9.9	9310.0	3140.0
RC-03-Z	6236.2	8.6	6066.1	-0.3	9.6	9779.8	3053.1
RC-04	6094.3	6.9	5582.2	-0.3	9.0	10240.8	2981.9
RC-05	6257.5	9.4	6497.4	-0.3	10.6	10195.9	3218.7
RC-06	6938.6	7.5	6164.3	-0.2	11.3	9895.1	3268.2
RR-01	9046.4	11.2	73670.5	-0.2	22.5	16193.5	9556.2
RR-02	9458.9	6.4	65230.2	-0.2	15.4	13026.0	8296.6

CFDA Sediment Digests - Dilution & Weight Corrected Data

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Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
Blank	-0.8	0.5	4.2	-0.1	-0.6	-0.2	1.8
RR-03	9321.9	7.1	78715.7	-0.3	18.2	14502.9	10102.0
RR-04-X	9116.4	4.6	64974.0	-0.2	17.3	13494.6	9266.3
RR-04-Y	8944.6	4.6	68558.8	-0.3	22.6	15590.6	9824.1
RR-04-Z	8898.2	4.3	62087.6	-0.3	21.8	15296.9	9768.0
RR-05-X	7885.3	12.1	63761.7	-0.2	14.1	11892.9	7965.2
RR-05-Y	8166.7	10.4	62475.0	-0.1	14.7	12295.1	8146.7
RR-05-Z	8003.6	13.5	61550.7	-0.0	14.5	12090.3	8053.6
RR-09 d	9436.2	7.5	72171.1	-0.1	21.1	15493.8	9746.1
BH-08-A s	11402.3	143.0	11802.4	10.6	136.3	28905.8	5131.0
USGS SED2	6412.6	153.1	16606.6	6.7	1093.4	21108.4	4591.8
Blank	-0.5	0.3	4.1	-0.0	0.0	2.9	0.6
STD 1 Blank	0.00	0.02	0.00	-0.00	-0.00	0.02	0.01
STD 6 composite	2.01	1.97	20.10	2.00	1.97	2.01	19.50
Milli-Q water	-0.01	0.01	0.01	-0.00	-0.00	-0.01	0.01
Blank	-0.8	-0.1	3.0	-0.1	-0.4	0.1	0.7
RR-06	8520.7	6.3	60790.4	-0.2	15.3	12459.5	7877.6
RR-07	9073.6	6.4	79131.6	-0.3	28.6	15006.0	9343.7
RR-08	9586.2	7.9	79768.1	-0.1	23.5	15993.6	9966.0
RR-09	9094.5	8.6	73356.0	-0.1	21.4	15290.8	9664.2
RR-10	8445.2	10.8	77038.4	-0.1	19.6	13624.5	8695.6
CF-55-A	8358.4	56.4	39039.0	3.6	496.8	14314.3	4644.6
CF-55-B	9056.4	53.7	39584.2	3.7	501.1	15094.0	4828.1
CF-01-X	6482.2	36.2	56032.7	2.8	365.1	10587.3	4015.2
CF-01-Y	6708.7	34.1	56388.7	2.9	363.6	10697.9	4109.2
CF-01-Z	6887.2	35.2	50179.9	2.6	356.0	11195.5	4238.3
Blank	-0.3	1.1	2.9	-0.1	-0.2	0.1	1.9
CF-02	6590.0	34.0	56400.0	2.8	371.9	10800.0	4190.0
CF-03-A	6917.2	42.9	53378.6	4.9	435.2	11995.2	4308.3
CF-03-B	6997.2	41.7	53478.6	4.9	436.5	11995.2	4308.3
CF-34	8554.9	54.6	58265.0	4.2	537.4	13791.7	4947.0
CF-04	7700.7	40.4	78106.2	3.6	443.6	12185.4	4664.4
CF-33	8572.0	46.2	64590.3	4.3	488.1	13518.9	4816.7
CF-32	9464.3	55.4	51069.3	5.0	587.2	15190.9	5156.9
CF-01-X d	6807.3	34.8	55277.9	2.8	360.3	10895.6	4058.4
LB-03 s	8281.7	133.0	12302.5	10.8	151.3	15403.1	4290.9
USGS SED2	6921.1	158.3	17227.5	6.9	1101.8	22335.7	4767.6
Blank	-0.5	-0.8	3.6	-0.0	0.4	1.0	1.7
Blank again	-0.7	-1.3	3.3	-0.1	0.1	0.0	0.0
STD 1 Blank	-0.01	0.00	0.01	-0.00	0.00	0.01	0.02
STD 6 composite	1.99	1.98	20.10	1.98	1.95	2.00	19.20
STD 2	-0.01	-0.01	99.90	9.82	9.77	0.02	97.50
STD 3	9.79	0.02	0.05	-0.01	-0.01	10.00	0.05
STD 4	0.05	10.00	0.01	-0.00	-0.00	0.01	0.02
STD 2 again	-0.02	0.01	99.20	9.76	9.73	0.02	97.00

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# Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
Std. 6 composite	2.02	2	20.5	2.038	2.009	2.02	19.9
Std. 1 10% HCl Blank	-0.034	-0.006	0.01	0.0013	0.0005	0.001	0.008
Milli-Q water	-0.014	0.005	0.006	0.0009	0.0017	-0.004	0.035
Blank	-1.4	-0.5	4.8	0.1	1.4	1.8	1.6
CF-31	9236.3	68.1	23290.7	6.8	694.4	18192.7	5407.8
CF-05	7190.0	41.7	52100.0	5.2	502.4	12400.0	4610.0
CF-06	6415.1	43.9	61649.3	3.5	425.4	11209.0	4373.5
CF-06-Y	7816.9	53.5	50879.6	4.6	553.8	13294.7	4778.1
CF-06-Z	7936.3	54.8	56645.3	4.7	563.0	13310.6	4853.9
CF-07	7192.8	44.8	52247.7	3.8	464.3	12287.7	4545.5
CF-54	9209.2	70.0	38038.0	4.9	623.1	15515.5	5175.2
CF-08	7825.3	48.9	30281.8	3.1	411.3	12792.3	4687.2
CF-09	7958.4	50.3	39392.1	4.4	512.1	13297.3	4659.1
CF-10	8116.8	56.3	35985.6	4.2	537.5	13994.4	4678.1
Blank	-0.4	0.6	12.8	0.2	2.2	5.2	4.7
CF-13-X	8851.1	57.7	30269.7	4.1	592.5	15884.1	5114.9
CF-13-Y	8078.4	62.0	33693.3	4.9	613.0	14397.1	4889.0
CF-13-Z	7883.7	61.8	28677.0	4.4	632.7	15187.8	4796.2
CF-14	7579.5	55.8	35674.2	4.0	499.6	13441.0	4770.0
CF-11	7913.7	63.2	26578.7	4.4	575.0	14588.3	4636.3
CF-35	9996.0	101.0	28788.5	5.9	796.5	18292.7	5507.8
CF-15	7445.5	58.6	33479.9	4.8	576.4	13591.8	4497.3
CF-03-A d	6267.5	42.2	54478.2	5.0	435.5	11295.5	4128.3
RR-07 s	9078.2	106.0	81783.6	9.7	124.1	15496.9	9338.1
USGS SED2	6030.0	160.0	17200.0	6.9	1104.0	21000.0	4460.0
Blank	2.5	-0.3	9.6	0.1	2.7	6.1	4.6
Blank	0.6	-1.9	6.2	0.1	2.0	2.5	2.5
Std 1 Blank	0.01	-0.024	0.011	0.0016	0.0037	0.023	0.017
Std 6 composite	2.03	1.99	20.7	2.019	1.949	2.07	19.3
Std 6 composite	2.01	2.01	20.3	2.03	1.985	1.98	19.7
Std 1 Blank	-0.028	0.011	-0.055	0.0007	0.012	-0.018	-0.055
Milli-Q water	-0.034	0.011	-0.059	0.0011	-0.0015	-0.034	-0.063
Blank	-2.7	1.0	-1.0	-0.0	2.4	-0.8	-3.9
Blank	-4.0	-0.9	-4.5	-0.0	0.3	-1.5	-5.3
CF-15-Y	11197.8	98.0	22795.4	5.5	712.6	18596.3	5858.8
CF-15-Z	11304.5	99.5	27310.9	5.3	696.0	19107.6	5922.4
CF-36	9538.1	58.6	30693.9	5.0	766.2	15996.8	5258.9
CF-37	13392.0	22.4	15590.6	1.3	245.2	17089.7	6646.0
CF-12	8300.0	55.5	35900.0	5.3	711.0	14400.0	4780.0
CF-21	8670.0	58.0	33800.0	7.5	785.3	15200.0	4930.0
CF-22-X	8206.6	58.9	38130.5	5.4	727.7	14611.7	4863.9
CF-22-Y	8318.3	59.3	40691.9	5.4	728.2	14797.0	4869.0
CF-22-Z	9293.7	60.4	38315.3	5.1	722.7	15906.4	5492.2
CF-53	11555.2	112.5	32053.1	8.1	1159.5	20497.9	5998.7
Blank	-0.7	-1.4	-3.0	0.0	0.4	-0.6	-5.8
CF-20	8206.6	58.9	38130.5	5.4	727.7	14611.7	4899.0

CFDA Sediment Digests - Dilution & Weight Corrected Data

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Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
CF-38	8731.3	85.3	38661.3	6.6	983.7	16383.6	5104.9
CF-39	9460.0	97.8	37400.0	6.1	1031.0	18400.0	5670.0
CF-40	9358.4	74.0	41514.8	5.5	917.6	16686.3	5458.2
CF-41	10098.0	91.5	38592.3	6.2	1054.8	18496.3	5768.8
CF-19	8481.7	55.9	37807.6	4.8	747.6	15003.0	4981.0
CF-18-A	8668.3	61.4	40391.9	5.7	843.5	15896.8	5119.0
CF-11 d	8916.4	60.6	26689.3	4.4	600.0	15593.8	4978.0
CF-35 s	11595.4	201.9	29088.4	16.7	942.0	19792.1	5987.6
USGS SED2	7078.5	157.2	17120.5	7.2	1159.4	22727.2	4925.9
Blank	0.1	0.6	-2.9	0.14	1.2	0.5	-3.8
Std 1 Blank	-0.005	-0.004	-0.066	0	0.0072	-0.003	-0.052
Std 6 composite	2.05	1.99	20.3	2.03	2.018	2.02	19.8
Milli-Q water	-0.013	0	-0.064	0.0003	-0.002	-0.034	-0.049
Blank	-1.2	1.3	-5.2	-0.0	0.7	-1.2	-5.6
CF-18-B	7343.2	64.8	40072.0	5.6	828.9	14425.9	4788.6
CF-52-X	9564.3	111.9	36078.3	7.7	1126.3	18988.6	5436.7
CF-52-Y	10200.0	114.0	39200.0	8.2	1209.0	19700.0	5700.0
CF-52-Z	9775.6	112.2	37760.3	7.9	1198.9	19130.6	5649.0
CF-17	9116.4	101.0	29788.1	7.2	1194.5	17992.8	5127.9
CF-42	10697.9	142.0	26394.7	11.1	1485.7	22595.5	5828.8
CF-43	8751.8	121.0	39007.8	7.4	1251.3	18003.6	5311.1
CF-44	10300.0	123.0	34400.0	7.3	1390.0	20400.0	6140.0
CF-45	9998.0	155.0	31293.7	6.4	1274.7	20895.8	5968.8
Blank	-0.5	0.0	-0.4	-0.0	1.4	1.5	-2.7
CF-16	7335.6	93.3	39176.5	7.1	1016.4	15590.6	4587.2
CF-46-A	12694.9	58.0	23090.8	2.5	520.3	19592.2	7437.0
CF-46-B	13102.6	58.6	23004.6	2.6	546.4	19904.0	7651.5
CF-23	7736.9	109.0	48280.7	7.7	1183.5	16793.3	4918.0
CF-47	9060.0	124.0	54200.0	9.8	1302.0	17700.0	5080.0
CF-23	7776.9	109.0	48280.7	7.8	1186.5	16893.2	4908.0
CF-25	11097.8	179.0	27694.5	7.3	1537.7	25195.0	6128.8
CF-24	9063.6	121.0	53521.4	9.7	1306.5	17607.0	5062.0
CF-51	11995.2	296.9	33186.7	9.2	2357.1	32886.8	6797.3
CF-36 d	9416.2	62.8	31287.5	5.1	761.1	16393.4	5227.9
CF-22-X s	9026.4	164.9	39384.2	16.2	843.2	15993.6	5127.9
USGS SED2	7085.7	157.9	17789.3	7.4	1165.3	22886.3	4977.0
Blank	-0.3	-1.2	-2.5	0.0	1.9	1.9	-4.3
Blank	-1.1	0.1	-4.6	0.0	1.5	-1.1	-5.0
Std 1 Blank	0	-0.005	-0.067	-0.0005	0.0195	-0.003	-0.035
Std 6 composite	2.01	1.99	20.5	2.03	2.012	2.04	19.7
ICS Sol A	208	-0.029	500	-0.0037	0.0085	94.8	517
ICS Sol AB	207	0.985	501	0.5147	1.013	94.9	516
Std 2	0.033	-0.013	101	9.874	9.921	0.038	98.4
Std 3	9.94	0.009	-0.013	-0.0064	-0.0033	10.2	-0.015
Std 4	0.04	10	-0.053	0.0049	0.0054	0.003	-0.049

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Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
Std 6 composite	2.02	2.03	20.2	2.017	1.98	2	19.7
Std 1 Blank	0.02	0.009	0.008	0.0024	-0.0057	0	0.005
Milli-Q water	-0.023	0.011	-0.002	0.0006	-0.0134	-0.024	-0.008
Blank	-1.80	-0.20	7.00	0.05	-0.12	-0.10	1.0
CF-27	9221.8	161.0	43208.6	8.5	1446.3	20904.2	5541.1
CF-48A	11100.0	191.0	31700.0	10.0	1561.0	25300.0	6610.0
CF-48B	11895.2	198.9	32487.0	10.2	1607.4	26689.3	6907.2
CF-26	9440.0	179.0	53300.0	8.8	1462.0	21600.0	6780.0
CF-49-Y	11097.8	216.0	54389.1	9.7	1877.6	25195.0	8438.3
CF-49-Z	10500.0	229.0	54700.0	9.6	1687.0	24900.0	8080.0
CF-28	8576.6	205.9	63074.8	10.3	1650.3	20491.8	6217.5
CF-30	9670.0	157.0	72000.0	7.4	1067.0	21400.0	8580.0
CF-50-X	10198.0	145.0	91881.6	8.1	1073.8	20495.9	9788.0
CF-50-Y	10206.1	158.1	84550.7	10.5	1271.8	20812.5	9345.6
Blank	2.1	-0.8	8.4	0.1	1.1	0.4	1.2
CF-50-Z	10397.9	194.0	84983.0	8.6	1225.8	21095.8	9688.1
CF-29	0.0	0.0	0.0	0.0	909.7	17589.4	10493.7
SB-01	10504.2	233.1	24309.7	17.1	3918.6	27911.2	5382.2
CF-29 1:2 Dil.	10193.9	120.7	114931.0	6.0	928.0	18508.9	10613.6
SB-01-Y	10902.2	204.0	25305.1	19.4	3303.7	32406.5	5781.2
SB-01-Z	11100.0	257.0	69600.0	25.2	4079.0	27700.0	8880.0
SB-02-A	11463.8	547.0	9543.1	43.2	10397.9	34693.2	4193.4
SB-02-B	10493.7	539.7	9464.3	42.4	10153.9	33479.9	3967.6
SB-03-Y d	10655.1	767.0	7478.7	27.3	10283.2	36287.7	3588.6
CF-43 s	9196.3	228.9	38984.4	17.0	1320.5	18692.5	5307.9
USGS SED2	6421.3	163.0	17203.4	6.9	1122.2	21704.3	4600.9
Blank	-0.2	-3.5	8.4	0.1	3.1	0.8	0.8
Blank	-2.8	-3.0	7.0	-0.0	2.1	-0.4	-0.1
Std 1 Blank	-0.018	-0.028	0.003	0.0012	0.0357	-0.006	-0.018
Std 6 composite	2.06	2.04	20.8	2.022	1.975	2.09	19.6
ICS Sol A	207	-0.027	497	-0.0022	0.0032	95.3	507
ICS Sol AB	206	1.01	499	0.5063	0.9768	95.5	506
Std 6 composite	1.99	1.99	20.5	2.014	1.962	2.06	19.4
Std 1 Blank	-0.028	-0.014	0.014	0.0012	0.0089	-0.004	-0.005
Milli-Q water	-0.038	-0.014	0.004	0.0012	-0.0124	-0.023	-0.02
Blank	-1.5	-1.8	2.4	0.1	0.6	-0.7	-2.0
SB-03-X	10500.0	661.0	7360.0	31.6	9457.0	35100.0	3560.0
SB-03-Y	11595.4	768.7	7656.9	30.0	10915.6	37784.9	3818.5
SB-03-Z	12095.2	752.7	7247.1	32.4	11145.5	38484.6	3768.5
SB-04	12100.0	1130.0	6550.0	23.9	8638.0	43400.0	3740.0
SB-05-Y	10989.0	535.5	8451.5	44.3	11258.7	32967.0	3776.2
SB-05-Z	10302.1	461.1	9091.8	38.0	7532.5	31406.3	3780.8
SB-06-X	14285.7	526.5	8022.0	44.4	8724.3	39760.2	4046.0
SB-06-Y	13802.8	513.1	8961.8	43.2	8015.6	44008.8	4210.8
SB-06-Z	15896.8	525.9	7908.4	46.4	9009.2	43291.3	4319.1
SB-07	11700.0	760.0	7240.0	26.9	10240.0	38200.0	3830.0

CFDA Sediment Digests - Dilution & Weight Corrected Data

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Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
Blank	-1.2	-0.5	3.6	0.1	4.9	3.6	-0.8
SB-05-Y	11088.9	541.5	8521.5	44.8	11298.7	33366.6	3806.2
SB-05-Z	10502.1	468.1	9301.9	39.0	7629.5	32206.4	3850.8
SB-06-X	14385.6	530.5	8032.0	43.9	8792.2	40059.9	4075.9
SB-08	11604.6	595.2	7953.2	34.7	11494.6	35414.2	3741.5
SB-09	10500.0	539.0	8420.0	31.2	8529.0	33800.0	3700.0
SB-10	10795.7	648.7	7457.0	36.7	11595.4	36985.2	3518.6
SB-11	12212.2	750.8	7687.7	32.4	11501.5	39039.0	3843.8
SB-12	12207.3	467.3	9145.5	37.9	7404.4	38423.0	4362.6
SB-13-A	11892.9	452.7	10693.6	38.7	7424.5	35778.5	4547.3
SB-13-B	11904.8	441.2	10504.2	37.2	7190.9	35514.2	4531.8
SB-13-B d	12209.8	437.3	10508.4	37.2	7233.8	35628.5	4583.7
CF-30 s	11313.6	260.3	73388.0	17.6	1162.4	23628.3	9110.9
USGS SED2	6551.3	161.0	18003.6	7.2	1140.2	22604.5	4781.0
Blank	0.2	-2.0	3.8	0.3	2.4	0.8	1.4
Std 1 Blank	-0.004	-0.022	0.009	0.0018	0.0364	-0.006	0.007
Std 6 composite	2.01	2.03	20.9	2.046	1.975	2.12	19.9
Std 2	0.006	-0.008	104	10.13	9.813	0.016	101
Std 2	-0.028	-0.008	103	10.05	9.788	0.012	100
Std 3	9.97	-0.007	0.044	-0.005	0.0004	10.6	-0.004
Std 4	0.008	10.2	0.008	0.003	0.0082	0	-0.008
ICS Sol A	207	0.023	510	-0.002	0.0056	98.2	516
ICS Sol AB	206	1.05	508	0.5154	0.9878	98.2	516
Milli-Q water	-0.02	-0.011	0.006	0.0011	-0.0126	-0.018	-0.005

CFDA Sediment Digests - Dilution & Weight Corrected Data

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# Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Sb2068	Ti3349	Zn2138
Std 6 composite	2.06	2.00	2.08	2.07	1.95	2.03	2.07
Std 1	0.00	-0.00	-0.01	0.00	0.01	-0.00	0.00
Milli-Q Water	0.00	0.00	-0.00	0.00	-0.01	0.00	-0.00
Blank	0.0	-0.4	2.5	0.8	-1.9	-0.3	-0.0
BC-01	1309.1	11.4	1473.5	36.9	13.0	619.8	229.0
BC-02-X	1789.0	12.2	1290.0	41.4	10.8	628.6	300.5
BC-02-Y	2008.2	12.5	1386.7	43.9	16.1	635.8	293.7
BC-02-Z	2197.2	11.4	1776.1	39.0	16.8	621.2	240.9
BC-03	2141.4	9.7	1750.4	49.0	16.2	609.4	359.9
BC-04	1603.0	9.7	1179.3	44.1	13.5	535.9	584.7
BC-05-X	1577.9	8.4	1010.6	55.3	13.7	631.5	350.9
BC-05-Y	1616.4	9.4	1018.4	55.4	11.6	677.7	358.1
BC-05-Z	1782.6	9.5	1259.7	50.5	15.4	645.6	342.5
BC-06-A	1447.5	9.4	1904.6	55.2	17.8	484.7	490.5
Blank	0.3	-0.5	3.2	0.7	-2.1	-0.3	0.4
BC-06-B	1478.9	9.4	1927.3	54.5	15.4	480.0	495.1
BH-01	1679.0	11.9	2080.0	72.2	12.6	283.1	165.5
BH-01-Y	3394.8	12.4	1824.7	82.1	17.3	236.3	184.8
BH-01-Z	3320.2	12.9	1908.5	84.3	14.5	220.9	181.1
BH-02	650.1	13.6	1119.6	125.0	22.2	336.3	209.0
BC-03 d	2137.4	10.6	1870.4	49.9	17.9	601.4	364.6
BH-04-X	2266.5	9.0	1550.3	38.0	10.5	200.8	110.9
BH-03	1591.7	11.8	1089.8	190.0	24.8	291.8	229.2
BC-05-X s	1812.9	9.2	1024.5	113.5	14.1	614.4	571.9
USGS SED2	1511.3	10.0	794.2	150.0	17.0	417.2	1506.3
Blank	0.1	-0.1	11.3	0.8	-2.0	-0.2	0.6
STD 1 Blank	0.00	-0.00	0.14	0.01	-0.02	-0.00	0.00
STD 6 composite	2.12	2.08	2.28	2.15	2.07	2.10	2.15
STD 6 composite	1.99	1.96	2.05	1.98	1.98	1.98	2.02
STD 6 composite	2.04	2.02	2.06	2.06	2.02	2.02	2.07
STD 1 Blank	0.00	0.01	-0.01	0.00	0.01	-0.00	0.00
Milli-Q water	-0.00	0.00	0.01	-0.00	0.01	0.00	-0.00
Blank	0.1	-0.1	1.6	-0.1	2.4	-0.0	-0.0
BH-04-Y	909.6	11.3	1560.6	60.1	12.4	286.1	165.9
BH-04-Z	790.5	11.4	1570.6	61.3	15.2	286.1	171.1
BH-05	1092.9	12.2	974.8	56.8	13.9	332.8	126.4
BH-05-Y	757.1	13.3	834.3	66.6	16.5	274.9	125.7
BH-05-Z	1280.6	11.9	942.1	62.2	17.1	264.3	121.2
BH-06	3198.6	9.7	1424.3	28.6	11.1	212.7	72.1
BH-07	526.3	11.7	1949.2	86.7	14.2	270.9	211.0
BH-08-A	1660.7	12.1	2155.7	81.7	14.8	296.6	205.0
BH-08-B	1665.7	12.3	2148.3	81.0	15.6	302.7	207.0
BH-09	5532.9	12.5	1612.9	76.7	15.5	291.2	158.4
Blank	0.9	0.3	3.5	0.2	0.0	0.1	0.3
BH-10	802.7	11.2	1259.7	31.2	21.0	117.4	90.7
BH-11	1301.0	10.9	1610.0	48.5	16.4	226.6	126.8

CFDA Sediment Digests - Dilution & Weight Corrected Data

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Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Sb2068	Ti3349	Zn2138
BH-12	1224.5	10.6	1369.5	53.6	13.3	266.2	120.8
FC-01-X	3400.0	8.0	1119.3	202.9	21.5	187.4	600.5
FC-01-Y	3272.7	9.0	1100.2	210.0	23.4	200.6	620.2
FC-01-Z	2851.7	7.8	1072.1	192.4	19.9	200.7	573.9
FC-02	2581.4	6.4	1098.9	257.7	22.7	192.9	719.5
BH-04-Y s	1122.6	11.8	1579.4	112.0	14.8	286.3	376.5
USGS SED2	1487.7	10.4	809.8	151.0	19.7	442.1	1471.7
BH-01 d	1619.4	11.8	2028.0	70.0	15.6	281.6	157.2
Blank	0.5	0.3	4.9	0.8	-0.3	0.09	0.25
STD 1 Blank	0.00	0.00	0.03	0.01	0.00	0.00	0.00
STD 6 composite	2.03	2.01	2.09	2.05	1.97	2.01	2.05
10% HCl Blank	0.00	0.01	0.10	0.01	0.02	0.00	0.00
ICS Sol A	-0.01	0.01	-0.06	-0.00	-0.05	-0.00	0.02
ICS Sol AB	0.96	0.01	-0.10	0.49	-0.04	-0.00	1.03
10% HCl Blank	0.00	0.00	0.07	0.01	0.01	-0.00	0.00
Milli-Q H2O	0.00	0.01	0.10	0.01	0.01	0.00	0.00
1000 ppm P	0.00	0.01	1130.00	0.01	0.02	0.00	0.01

CFDA Sediment Digests - Dilution & Weight Corrected Data

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# Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Sb2068	Ti3349	Zn2138
STD 6 composite	2.04	1.98	2.04	2.07	1.97	2.01	2.06
STD 1 Blank	0.00	0.00	-0.02	0.00	0.02	-0.00	0.00
Milli-Q Water	-0.00	0.00	0.04	0.00	0.02	0.00	-0.00
Blank	-0.0	0.4	-4.4	0.8	-0.3	-0.0	-0.1
FC-03	4252.1	7.2	1021.2	326.4	35.6	218.3	930.9
FC-03-Y	2028.6	10.5	1279.9	312.9	24.2	188.7	787.8
FC-03-Z	1803.6	9.9	1279.0	289.8	23.3	190.4	731.9
GC-01	878.4	15.9	1790.0	22.3	14.0	407.3	84.7
GC-02-X	602.7	11.4	1218.0	18.3	12.9	366.5	68.7
GC-02-Y	613.2	10.7	1205.9	17.8	9.0	347.0	67.1
GC-02-Z	527.2	11.5	1183.1	17.7	13.0	365.1	68.0
GC-03	1113.9	10.8	1134.8	17.5	9.5	300.7	67.2
LB-01	1569.7	15.4	1513.0	65.7	11.4	133.6	182.3
LB-02-X	1211.2	17.4	1560.3	70.2	13.0	158.1	165.4
Blank	0.2	0.6	-0.9	0.9	1.2	-0.1	0.1
LB-02-Y	2243.6	16.0	1639.7	58.2	12.7	139.8	160.6
LB-02-Z	1888.5	17.0	1621.3	68.5	13.3	142.0	169.6
LB-03	2768.3	14.4	1898.9	53.8	10.0	144.3	165.0
LB-03 again	2774.3	14.6	1918.8	53.0	11.7	144.6	165.4
RC-01	677.5	7.6	1269.0	11.7	8.9	226.0	32.4
RC-01-Y	263.4	10.3	1161.4	17.7	13.2	342.7	36.3
RC-01-Z	234.8	12.1	1191.0	18.4	11.9	379.5	40.0
RC-02	280.0	8.3	1070.4	15.7	9.4	249.8	34.1
GC-02-Z d	525.4	11.2	1179.1	19.0	10.1	360.3	68.2
BH-07 s	749.1	12.6	2028.8	143.9	16.5	282.9	427.5
USGS SED2	1526.2	10.9	827.4	154.8	20.6	434.5	1500.1
Blank	0.3	0.7	1.4	1.2	1.2	0.0	0.7
STD 1 Blank	0.00	0.00	0.07	0.01	0.01	-0.00	0.01
STD 6 composite	2.04	2.02	2.22	2.11	2.02	2.01	2.09
ICS Sol A	-0.01	0.01	-0.17	0.01	0.01	-0.00	0.02
ICS Sol AB	0.96	0.01	-0.07	0.52	0.01	-0.00	1.03
STD 1 Blank	0.00	0.00	0.05	0.02	-0.00	-0.00	0.01
STD 6 composite	2.04	2.00	2.04	2.05	2.01	2.01	2.05
STD 1 Blank	0.00	0.00	0.03	-0.01	0.01	0.00	0.00
Milli-Q Water	0.00	-0.00	0.02	-0.01	0.00	0.00	-0.00
Blank	0.1	0.2	-2.3	-0.3	0.1	0.1	-0.1
RC-02-Y	296.3	8.8	1009.4	12.9	11.3	271.0	33.9
RC-02-Z	565.5	9.2	1199.5	13.4	9.4	287.3	36.4
RC-03	616.6	7.5	1151.6	11.6	9.0	196.6	35.7
RC-03-Y	142.5	6.8	1300.0	9.3	7.9	211.1	32.2
RC-03-Z	150.4	6.5	1341.3	7.4	6.8	206.1	30.9
RC-04	269.0	5.7	1345.4	9.6	7.0	210.8	35.9
RC-05	507.8	6.7	1359.5	8.6	6.9	222.5	38.4
RC-06	420.4	6.9	1387.7	9.4	8.1	230.8	42.0
RR-01	711.7	18.8	1019.6	22.8	16.9	192.2	72.4
RR-02	487.5	11.6	908.8	12.4	13.9	136.6	52.6

CFDA Sediment Digests - Dilution & Weight Corrected Data

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Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Sb2068	Ti3349	Zn2138
Blank	0.1	-0.4	3.3	-1.6	1.7	0.0	-0.0
RR-03	373.9	16.5	961.2	13.4	15.9	210.6	58.8
RR-04-X	415.1	16.9	795.7	13.1	14.8	152.3	54.1
RR-04-Y	552.2	18.0	988.4	16.6	14.9	201.7	59.3
RR-04-Z	490.1	17.5	979.8	15.6	13.4	187.5	57.9
RR-05-X	549.5	10.4	852.5	12.4	12.8	122.8	48.8
RR-05-Y	593.7	11.2	863.7	13.1	13.6	123.5	51.6
RR-05-Z	526.1	10.7	836.3	11.4	12.9	124.9	48.3
RR-09 d	581.8	15.9	1009.6	16.8	16.7	143.2	65.0
BH-08-A s	1864.4	12.7	2190.4	132.0	17.3	335.1	413.3
USGS SED2	1442.6	9.6	796.3	146.1	19.6	421.4	1407.6
Blank	0.3	0.2	7.5	0.7	1.9	0.1	0.5
STD 1 Blank	0.00	-0.00	0.07	-0.00	0.02	0.00	0.00
STD 6 composite	2.01	1.99	2.12	2.02	1.98	1.99	2.04
Milli-Q water	0.00	-0.00	0.08	0.00	0.01	0.00	0.00
Blank	0.1	-0.6	8.7	-0.2	1.4	0.0	0.2
RR-06	508.1	10.6	833.0	12.0	12.1	142.5	47.9
RR-07	515.2	20.8	853.3	18.4	15.1	215.6	64.3
RR-08	631.9	18.5	972.6	20.3	17.1	165.0	68.0
RR-09	590.9	16.2	1029.4	18.2	14.5	142.0	65.0
RR-10	542.3	14.2	1081.9	14.3	15.0	115.5	58.8
CF-55-A	2060.1	10.4	1251.3	98.8	12.9	214.7	914.6
CF-55-B	2077.2	10.6	1279.5	97.8	13.0	223.6	932.3
CF-01-X	1609.1	8.8	1168.6	72.7	11.9	177.5	780.1
CF-01-Y	1414.7	8.4	1139.8	71.4	12.7	179.0	752.6
CF-01-Z	1296.5	8.7	1129.5	70.9	13.0	189.8	739.6
Blank	0.1	-0.4	10.1	0.8	1.1	-0.0	0.4
CF-02	1333.0	8.4	1120.0	72.3	10.2	179.7	762.8
CF-03-A	4045.4	10.2	1259.5	80.2	13.1	190.3	1145.5
CF-03-B	4079.4	10.9	1259.5	80.7	13.0	189.9	1121.6
CF-34	1762.9	10.4	1259.2	101.9	14.4	191.2	1043.4
CF-04	1705.0	8.9	1168.6	83.9	12.6	194.6	883.3
CF-33	1587.2	10.5	1171.6	97.8	13.9	213.7	1021.4
CF-32	1722.0	11.4	1279.2	111.9	16.0	207.6	1224.3
CF-01-X d	1582.4	8.5	1159.5	72.4	12.1	182.1	771.4
LB-03 s	2964.6	13.8	1900.4	100.0	12.7	142.2	362.7
USGS SED2	1472.4	10.5	834.3	149.2	18.5	446.0	1466.3
Blank	0.2	-0.2	13.6	1.0	0.0	0.0	0.6
Blank again	0.0	0.0	0.1	0.0	0.0	0.0	0.0
STD 1 Blank	0.00	0.00	0.15	0.01	0.02	0.00	0.01
STD 6 composite	1.99	1.97	2.17	2.04	1.97	1.97	2.03
STD 2	9.84	-0.00	0.25	9.97	0.15	0.00	9.91
STD 3	0.00	10.00	0.15	0.03	-0.02	9.85	0.04
STD 4	0.00	-0.01	10.20	-0.00	10.00	0.01	0.01
STD 2 again	9.78	0.00	0.25	9.88	0.14	0.00	9.85

CFDA Sediment Digests - Dilution & Weight Corrected Data

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# Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Sb2068	Ti3349	Zn2138
Std. 6 composite	2.042	2.02	2.08	2.07	2.03	2.021	2.067
Std. 1 10% HCl Blank	0.001	-0.004	0.104	-0.009	0.011	0.0013	0.0019
Milli-Q water	0.0008	0.001	0.032	0.008	0.018	0.0026	0.0016
Blank	0.1	-0.1	3.2	-1.6	0.8	-0.0	0.3
CF-31	1960.2	13.3	1549.4	141.9	17.2	204.2	1540.4
CF-05	1927.0	9.7	1270.0	91.5	14.6	188.6	1073.0
CF-06	1507.2	8.0	1231.0	77.1	13.0	184.7	875.4
CF-06-Y	1834.3	10.8	1249.5	100.0	14.6	194.0	1042.6
CF-06-Z	1641.3	10.3	1221.0	102.1	14.9	189.4	1076.9
CF-07	1464.5	9.1	1218.8	87.4	12.9	194.5	918.0
CF-54	1994.0	11.6	1251.3	120.1	15.0	209.4	1123.1
CF-08	1037.4	10.6	1169.3	78.0	14.4	197.4	832.1
CF-09	1818.6	9.4	1259.7	92.4	13.4	209.2	992.0
CF-10	2254.1	9.6	1339.5	98.5	15.4	208.9	1047.6
Blank	0.5	-0.3	18.1	0.3	1.9	0.2	0.9
CF-13-X	2443.6	11.2	1248.8	111.9	14.0	210.9	1447.6
CF-13-Y	2632.5	10.3	1349.7	113.0	15.8	191.3	1186.8
CF-13-Z	2312.1	11.5	1209.0	112.9	15.8	194.3	1796.6
CF-14	2167.7	9.3	1273.4	92.9	15.4	192.7	941.0
CF-11	2218.2	9.9	1388.9	107.9	17.6	205.5	1008.2
CF-35	2631.9	13.4	1359.5	155.9	20.0	206.1	1420.4
CF-15	2221.7	10.0	1239.3	99.2	16.0	192.0	1143.3
CF-03-A d	4068.4	9.8	1249.5	79.7	15.7	179.2	1155.5
RR-07 s	707.6	21.3	875.8	68.0	18.0	207.0	254.2
USGS SED2	1449.0	9.6	784.0	150.0	19.9	401.7	1497.0
Blank	0.4	0.1	16.9	2.2	3.1	0.4	0.9
Blank	0.1	-0.3	16.8	0.0	1.2	0.2	0.6
Std 1 Blank	0.001	-0.003	0.161	0.002	0.003	0.0014	0.0047
Std 6 composite	2.015	2.02	2.26	2.09	2.02	1.985	2.065
Std 6 composite	2.031	1.99	2.09	2.07	1.98	2	2.057
Std 1 Blank	0.0011	-0.001	-0.017	0.007	0.001	0.0001	0.0014
Milli-Q water	0.0003	0.002	0.067	0.017	-0.001	0.0024	-0.0003
Blank	0.1	0.2	2.3	1.9	-0.5	0.1	0.3
Blank	0.2	1.1	-1.0	0.5	0.5	-0.1	3.2
CF-15-Y	2943.4	12.9	1239.8	164.0	22.3	235.5	1426.7
CF-15-Z	3676.5	13.2	1290.5	162.1	18.3	224.0	1370.5
CF-36	3007.4	11.5	1299.7	105.0	13.0	228.4	1166.8
CF-37	755.4	14.7	942.4	46.1	16.8	243.7	403.9
CF-12	2994.0	11.5	1360.0	95.1	12.8	208.3	1169.0
CF-21	1726.0	11.7	1400.0	105.0	15.5	207.0	1266.0
CF-22-X	4870.9	11.9	1491.2	103.1	14.5	198.9	1046.8
CF-22-Y	3512.3	12.4	1489.7	108.0	15.6	204.2	1091.8
CF-22-Z	4770.9	13.4	1480.6	105.0	13.9	212.3	980.6
CF-53	3523.8	15.4	1457.0	172.8	18.6	231.3	1685.0
Blank	0.3	0.9	1.2	1.5	0.5	-0.1	3.6
CF-20	4103.2	12.5	1509.7	115.0	14.6	213.6	1162.8

CFDA Sediment Digests - Dilution & Weight Corrected Data

Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Sb2068	Ti3349	Zn2138
CF-38	3368.6	13.2	1448.6	133.9	14.8	213.7	1288.7
CF-39	5039.0	13.9	1400.0	153.0	16.2	211.6	1312.0
CF-40	2858.8	12.5	1336.9	130.7	15.5	228.2	1173.1
CF-41	4299.1	13.8	1469.7	148.0	15.5	224.8	1259.7
CF-19	2785.6	11.3	1380.3	110.0	13.5	221.3	994.5
CF-18-A	3384.3	12.5	1469.7	115.0	17.3	231.4	1118.8
CF-11 d	2258.1	11.4	1389.4	112.0	17.4	231.4	1023.6
CF-35 s	2890.8	13.6	1379.4	210.9	22.1	225.5	1633.3
USGS SED2	1509.8	10.2	791.9	154.2	18.2	454.3	1476.8
Blank	0.28	0.8	1	2.8	0.3	0.06	3.67
Std 1 Blank	0.0007	0.001	-0.006	0.008	0.014	-0.0015	0.0015
Std 6 composite	2.028	1.98	2.09	2.06	2	2.02	2.052
Milli-Q water	0.0006	0.002	0.077	0.01	-0.005	0.0012	0.0005
Blank	0.1	-0.1	-0.3	1.2	0.6	0	0.2502
CF-18-B	3354.0	11.1	1432.6	116.2	15.4	200.8	1114.0
CF-52-X	2887.3	13.2	1519.1	159.9	17.4	248.3	1380.2
CF-52-Y	3619.0	13.1	1560.0	164.0	19.4	257.6	1403.0
CF-52-Z	3601.8	12.9	1502.4	164.3	18.4	248.8	1385.2
CF-17	4121.4	12.0	1589.4	159.9	17.8	242.4	1432.4
CF-42	2579.5	14.2	1419.7	208.0	20.8	249.2	2142.6
CF-43	4002.8	12.5	1410.3	166.0	19.5	243.0	1431.3
CF-44	3434.0	14.4	1300.0	176.0	18.4	261.3	1551.0
CF-45	2830.4	13.4	1289.7	198.0	21.6	258.9	1459.7
Blank	0.5	0.0	7.1	3.3	1.1	0.3	0.7
CF-16	6016.4	11.6	1489.1	133.9	16.8	218.2	1307.2
CF-46-A	1567.4	17.8	1009.6	79.1	18.8	209.1	690.1
CF-46-B	1624.3	17.9	1010.2	79.1	20.1	208.7	705.5
CF-23	4900.0	11.7	1489.4	152.9	16.6	221.6	1419.4
CF-47	8058.0	15.0	1650.0	174.0	17.4	241.2	1593.0
CF-23	4894.0	12.2	1479.4	152.9	19.5	222.1	1418.4
CF-25	1827.6	12.7	1419.7	232.0	24.0	307.3	1506.7
CF-24	7985.2	14.3	1620.6	172.1	18.5	240.7	1572.6
CF-51	4029.4	13.3	1309.5	334.9	32.6	368.3	2058.2
CF-36 d	3005.8	11.9	1309.5	110.0	15.0	207.6	1169.5
CF-22-X s	5184.9	12.1	1549.4	160.9	16.1	204.6	1267.5
USGS SED2	1547.1	10.7	819.5	156.9	21.0	463.1	1510.1
Blank	0.3	-0.5	9.3	2.7	0.5	0.1	0.9
Blank	0.1	-0.2	10.4	2.6	-0.3	0.1	0.7
Std 1 Blank	0.0007	-0.003	0.103	0.028	0.009	-0.0017	0.0058
Std 6 composite	2.027	2.01	2.11	2.09	2	2.021	2.049
ICS Sol A	-0.0128	0.009	-0.117	0.017	-0.016	-0.0027	0.0184
ICS Sol AB	0.9593	0.007	-0.079	0.511	-0.003	-0.0024	1.022
Std 2	9.917	0.007	0.199	10	0.132	-0.0013	9.876
Std 3	0.0028	10.1	0.097	0.046	-0.008	10.08	0.0434
Std 4	0.0013	-0.002	10.2	0.032	10.2	0.0058	0.0058

CFDA Sediment Digests - Dilution & Weight Corrected Data

Analysis Report Averages Thu 03-26-92 02:50:13 PM page 1

Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Sb2068	Ti3349	Zn2138
Std 6 composite	2.019	2	2.08	2.03	1.99	2.014	2.044
Std 1 Blank	0.001	-0.001	0.053	0.021	0.004	0.0013	0.0021
Milli-Q water	0.0005	-0.002	0.036	-0.005	0.003	0.0017	0
Blank	0.3	0.3	1.6	-0.1	3.7	0.1	0.2
CF-27	4165.8	11.5	1370.3	206.0	22.1	324.1	1661.3
CF-48A	3611.0	13.5	1320.0	227.0	26.8	365.9	2047.0
CF-48B	3743.5	14.3	1349.5	234.9	27.0	376.2	2113.2
CF-26	9239.0	12.6	1400.0	195.0	25.5	330.1	1619.0
CF-49-Y	5670.9	14.0	1319.7	237.0	26.1	323.6	1836.6
CF-49-Z	5829.0	12.7	1390.0	225.0	24.5	311.4	1709.0
CF-28	21651.3	14.7	1339.5	195.9	23.1	297.0	1839.3
CF-30	11870.0	15.0	1410.0	150.0	25.1	308.7	1757.0
CF-50-X	13077.4	15.6	1389.7	167.0	23.1	315.8	1445.7
CF-50-Y	10486.3	15.4	1430.9	183.1	23.9	305.6	1827.1
Blank	0.5	0.4	7.4	0.2	0.5	-0.0	0.7
CF-50-Z	8846.2	14.7	1309.7	199.0	27.7	324.3	1727.7
CF-29	10014.0	13.8	0.0	0.0	22.8	0.0	1155.3
SB-01	1682.7	12.1	2270.9	499.2	24.5	429.5	4508.8
CF-29 1:2 Dil.	10243.9	15.2	1261.2	127.9	33.0	340.6	1197.9
SB-01-Y	1749.3	13.0	1930.4	495.1	24.8	443.4	4623.9
SB-01-Z	3002.0	14.2	2700.0	617.0	27.8	401.1	7389.0
SB-02-A	3826.3	15.6	4957.6	1267.1	30.5	406.1	11654.9
SB-02-B	3771.7	14.7	4867.1	1249.3	28.6	384.8	11453.1
SB-03-Y d	1954.1	9.4	4322.4	1648.5	39.8	423.7	8704.0
CF-43 s	4089.4	12.0	1439.4	209.9	19.1	253.9	1603.4
USGS SED2	1483.3	10.0	809.2	147.0	22.5	424.8	1435.3
Blank	0.4	0.1	18.8	1.0	2.3	0.1	1.0
Blank	0.3	0.1	12.4	1.3	2.3	-0.1	0.8
Std 1 Blank	0.0007	-0.003	0.11	0.002	-0.003	-0.0002	0.006
Std 6 composite	2.015	2.03	2.27	2.08	2.05	2.032	2.051
ICS Sol A	-0.0117	0.004	0.022	-0.022	0.039	-0.002	0.0187
ICS Sol AB	0.9372	0.008	-0.036	0.477	0.066	-0.0014	1.005
Std 6 composite	1.993	2	2.08	2.03	2.05	2.018	2.008
Std 1 Blank	0.0012	0.005	0.012	0.008	-0.015	0.0024	0.0028
Milli-Q water	0.0007	0.007	0.083	0.028	0.018	0.0033	0.0011
Blank	0.1	0.3	2.4	1.1	1.9	0.0	0.2
SB-03-X	2048.0	10.5	4300.0	1540.0	38.4	431.4	8960.0
SB-03-Y	1999.2	10.4	4478.2	1709.3	37.3	437.3	8777.5
SB-03-Z	1930.2	11.0	4448.2	1739.3	41.5	439.4	8908.4
SB-04	1699.0	8.1	3660.0	2170.0	51.5	478.8	6630.0
SB-05-Y	3175.8	14.2	5344.7	1328.7	25.0	402.4	11528.5
SB-05-Z	3039.6	13.1	5511.1	1180.2	27.5	388.2	9695.9
SB-06-X	1202.8	11.9	5394.6	1708.3	37.1	413.2	9007.0
SB-06-Y	1462.3	10.6	5571.1	1720.3	36.9	423.7	7925.6
SB-06-Z	1194.8	13.4	5768.8	1669.7	35.6	451.4	8097.4
SB-07	1974.0	10.0	4140.0	2140.0	42.2	451.8	7458.0

CFDA Sediment Digests - Dilution & Weight Corrected Data

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Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Sb2068	Ti3349	Zn2138
Blank	0.3	0.7	3.1	2.6	1.0	0.2	2.1
SB-05-Y	3199.8	14.0	5404.6	1328.7	29.7	405.1	11548.4
SB-05-Z	3100.6	13.1	5641.1	1200.2	26.2	395.1	9828.0
SB-06-X	1207.8	13.1	5384.6	1708.3	38.8	416.5	8964.0
SB-08	1919.8	12.9	4661.9	1530.6	34.6	396.7	10084.0
SB-09	2267.0	12.7	4600.0	1290.0	28.6	381.0	9121.0
SB-10	1785.3	11.8	4338.3	1789.3	38.4	405.8	9567.2
SB-11	2055.1	11.7	4684.7	1791.8	40.0	411.3	9555.5
SB-12	3426.1	13.4	4302.6	1300.8	32.1	436.2	8519.1
SB-13-A	2453.5	14.6	4007.6	1179.3	31.3	435.6	8682.8
SB-13-B	2412.0	13.9	3901.6	1150.5	28.4	440.7	8466.4
SB-13-B d	2400.9	13.5	3883.1	1140.9	30.3	444.3	8426.7
CF-30 s	12334.8	14.9	1451.7	199.2	25.3	348.7	1912.3
USGS SED2	1502.3	10.5	835.2	155.0	20.9	403.6	1392.3
Blank	0.2	0.7	10.3	3.4	1.2	0.2	1.2
Std 1 Blank	0.001	0.004	0.117	0.033	0.018	0.0023	0.0081
Std 6 composite	2.021	2.03	2.22	2.07	2.09	2.052	2.018
Std 2	9.98	0.006	0.235	10.1	0.132	0.0021	9.862
Std 2	9.937	0.008	0.234	10.1	0.131	0.0006	9.801
Std 3	0.0018	10.2	0.111	0.053	-0.012	10.2	0.0425
Std 4	0.0014	0.004	10.4	0.016	10.3	0.0068	0.0052
ICS Sol A	-0.012	0.012	-0.009	0.031	0.026	0	0.0178
ICS Sol AB	0.9522	0.013	-0.071	0.511	0.025	-0.0009	1.003
Milli-Q water	0.0011	0.007	0.124	0.035	0.016	0.0028	0.0028

Appendix C

Quality Assurance/Quality Control Documentation

Instrument QA/QC

Annual Interelement Interference Factors
Quarterly ICP Linear Range
Interelement Interference Checks

Sample Analysis QA/QC

Method Blanks
Duplicate Sample Digestions
Spiked Sample Digestions
Standard Reference Material

University of Montana - Department of Geology

ICP Interelement Correction Factors
(annually)

Contract: CFDA

Date : 4-30-92

Method: CFDA Sediment Digests

Analyte	Interelement Correction Factors for				
	Al	Ca	Fe	Mg	As
Al		-.0002	-.0015		
As	.0054				
Ca					
Cd 2288					.0079
Cu 3247			-.00013		
Fe 2599				.00027	
Mg					
Mn 2576			-.00273		
Ni					
Pb 2204	.00084				
Zn 2134			.0001		
Ti		.00003			

Comments: Determined February 17th and 18th, 1992

QA/QC Form 11

University of Montana - Department of Geology

ICP Interelement Correction Factors

(annually)

Contract: CFDA

Date : 4-30-92

Method: CFDA Sediment Digests

Analyte	Interelement Correction Factors for				
	Cu	Mn			
Al		.0053			
As		-.0016			
Ca					
Cd 2288					
Cu 3247		.0001			
Fe 2599		.0129			
Mg					
Mn 2576					
Ni					
Pb 2204					
Zn 2134	.00298				
Ti					

Comments: Determined February 17th and 18th, 1992

QA/QC Form 11

University of Montana - Department of Geology

ICP Linear Range

(quarterly)

Contract: CFDA

Date : 4-30-92

Method: CFDA Sediment Digests

Concentrations in units of mg//l (ppm)

Analyte	True Conc	Measured Conc	True Conc	Measured Conc
Al	100	106	10	10.0
As	100	103	10	9.98
Ca	500	525	100	101
Cd 2288	100	105.8	10	10.1
Cu 3247	100	106.2	10	9.99
Fe 2599	100	105	10	10.0
Mg	500	544	100	100
Mn 2576	100	110.6	10	10.1
Ni			10	10.1
Pb 2204	100	108	10	10.0
Zn 2134	100	103	10	10.1

Integration Time: 7 seconds

SS Cycles: one

Comments: data collected on Feb. 17th, 1992, 2-point standardization, page 1 of 2

QA/QC Form 12

University of Montana - Department of Geology

ICP Linear Range

(quarterly)

Contract: CFDA

Date : 4-30-92

Method: CFDA Sediment Digests

Concentrations in units of mg//l (ppm)

Analyte	True Conc	Measured Conc	True Conc	Measured Conc
Al	2	2.01	.2	.207
As	2	2.01	.2	.228
Ca	20	20.7	2	2.13
Cd 2288	2	2.07	.2	.213
Cu 3247	2	2.02	.2	.208
Fe 2599	2	2.05	.2	.211
Mg	20	20.1	2	2.07
Mn 2576	2	2.07	.2	.213
Ni	2	2.03	.2	.198
Pb 2204	2	2.08	.2	.199
Zn 2134	2	2.09	.2	.215

Integration Time: 7 seconds

SS Cycles: one

Comments: page 2 of 2

QA/QC Form 12

CFDA Sediment Digests - Interelement Interference Checks

Sample Name	File	Method	Date	Time	OpID	Type	Mode
Prepared Conc. A							
AB							
ICS Sol A	CFDA	CFDASED	02/24/92	13:41	dae	IC	CONC
ICS Sol AB	CFDA	CFDASED	02/24/92	13:44	dae	IC	CONC
%Diff.							
ICS Sol A	CFDA	CFDASED	02/28/92	12:10	dae	IC	CONC
ICS Sol AB	CFDA	CFDASED	02/28/92	12:13	dae	IC	CONC
%Diff.							
ICS Sol A	CFDA	CFDASED	03/20/92	15:11	dae	IC	CONC
ICS Sol AB	CFDA	CFDASED	03/20/92	15:14	dae	IC	CONC
%Diff.							
ICS Sol A	CFDA	CFDASED	03/26/92	12:39	dae	IC	CONC
ICS Sol AB	CFDA	CFDASED	03/26/92	12:41	dae	IC	CONC
%Diff.							
ICS Sol A	CFDA	CFDASED	03/26/92	14:33	dae	IC	CONC
ICS Sol AB	CFDA	CFDASED	03/26/92	14:36	dae	IC	CONC
%Diff.							

CFDA Sediment Digests - Interelement Interference Checks

Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
Prepared Conc. A	200		500			100	500
AB	200	1.00	500	0.50	1.00	100	500
ICS Sol A	209	-0.020	502	-0.0038	0.0088	95.0	523.0
ICS Sol AB	208	1.020	497	0.5185	1.0220	94.4	521.0
%Diff.	**4.0%**	**2.0%**	**-0.6%**	**3.7%**	**2.2%**	**-5.6%**	**4.2%**
ICS Sol A	207	-0.075	503	-0.0021	0.0073	94.9	514.0
ICS Sol AB	205	0.963	502	0.5172	1.0090	94.6	511.0
%Diff.	**2.5%**	**-3.7%**	**0.4%**	**3.4%**	**0.9%**	**-5.4%**	**2.2%**
ICS Sol A	208	-0.029	500	-0.0037	0.0085	94.8	517
ICS Sol AB	207	0.985	501	0.5147	1.013	94.9	516
%Diff.	**3.5%**	**-1.5%**	**0.2%**	**2.0%**	**1.3%**	**-5.1%**	**3.2%**
ICS Sol A	207	-0.027	497	-0.0022	0.0032	95.3	507
ICS Sol AB	206	1.01	499	0.5063	0.9768	95.5	506
%Diff.	**3.0%**	**1.0%**	**-0.2%**	**1.3%**	**-2.3%**	**-4.5%**	**1.2%**
ICS Sol A	207	0.023	510	-0.002	0.0056	98.2	516
ICS Sol AB	206	1.05	508	0.5154	0.9878	98.2	516
%Diff.	**3.0%**	**5.0%**	**1.6%**	**3.1%**	**-1.2%**	**-1.8%**	**3.2%**

%Diff = measured conc. of ICS AB/prepared conc. of ICS AB * 100

CFDA Sediment Digests - Interelement Interference Checks

Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Ti3349	Zn2138
Prepared Conc. A						
AB	1.00			0.50		1.00
ICS Sol A	-0.0123	0.011	-0.056	-0.00	-0.0011	0.02
ICS Sol AB	0.9633	0.008	-0.102	0.49	-0.0021	1.03
%Diff.	**-3.7%**			**-2.0%**		**3.0%**
ICS Sol A	-0.0134	0.008	-0.166	0.01	-0.0026	0.02
ICS Sol AB	0.9595	0.013	-0.072	0.52	-0.0019	1.03
%Diff.	**-4.0%**			**4.4%**		**3.1%**
ICS Sol A	-0.0128	0.009	-0.117	0.017	-0.0027	0.0184
ICS Sol AB	0.9593	0.007	-0.079	0.511	-0.0024	1.022
%Diff.	**-4.1%**			**2.2%**		**2.2%**
ICS Sol A	-0.0117	0.004	0.022	-0.022	-0.002	0.0187
ICS Sol AB	0.9372	0.008	-0.036	0.477	-0.0014	1.005
%Diff.	**-6.3%**			**-4.6%**		**0.5%**
ICS Sol A	-0.012	0.012	-0.009	0.031	0	0.0178
ICS Sol AB	0.9522	0.013	-0.071	0.511	-0.0009	1.003
%Diff.	**-4.8%**			**2.2%**		**0.3%**

%Diff = measured conc. of ICS AB/prepared conc. of ICS AB * 100

CFDA Sediment Digests - Method Blanks

Lab ID #	File	Method	Date	Time	OpID	Type	Mode
PDL							
4 CFDA-21	CFDA	CFDASED	02/24/92	10:37	dae	SB	CONC
15 CFDA-21	CFDA	CFDASED	02/24/92	11:10	dae	SB	CONC
26 CFDA-21	CFDA	CFDASED	02/24/92	11:44	dae	SB	CONC
33 CFDA-39	CFDA	CFDASED	02/24/92	12:27	dae	SB	CONC
44 CFDA-39	CFDA	CFDASED	02/24/92	12:58	dae	SB	CONC
55 CFDA-39	CFDA	CFDASED	02/24/92	13:29	dae	SB	CONC
4 CFDA 59	CFDA	CFDASED	02/28/92	10:51	dae	SB	CONC
15 CFDA 59	CFDA	CFDASED	02/28/92	11:21	dae	SB	CONC
27 CFDA 59	CFDA	CFDASED	02/28/92	11:59	dae	SB	CONC
36 CFDA 79	CFDA	CFDASED	02/28/92	12:39	dae	SB	CONC
47 CFDA 79	CFDA	CFDASED	02/28/92	13:09	dae	SB	CONC
58 CFDA 79	CFDA	CFDASED	02/28/92	13:41	dae	SB	CONC
62 CFDA 99	CFDA	CFDASED	02/28/92	13:52	dae	SB	CONC
73 CFDA 99	CFDA	CFDASED	02/28/92	14:24	dae	SB	CONC
84 CFDA 99	CFDA	CFDASED	02/28/92	14:54	dae	SB	CONC
85 CFDA 99 agai	CFDA	CFDASED	02/28/92	14:56	dae	SB	CONC
4 CFDA 118	CFDA	CFDASED	03/20/92	10:32	dae	SB	CONC
15 CFDA 118	CFDA	CFDASED	03/20/92	11:07	dae	SB	CONC
26 CFDA 118	CFDA	CFDASED	03/20/92	11:40	dae	SB	CONC
27 CFDA 118	CFDA	CFDASED	03/20/92	11:44	dae	SB	CONC
33 CFDA 118	CFDA	CFDASED	03/20/92	12:29	dae	SB	CONC
34 CFDA 137	CFDA	CFDASED	03/20/92	12:32	dae	SB	CONC
45 CFDA 137	CFDA	CFDASED	03/20/92	13:03	dae	SB	CONC
56 CFDA 137	CFDA	CFDASED	03/20/92	13:33	dae	SB	CONC
60 CFDA 156	CFDA	CFDASED	03/20/92	13:46	dae	SB	CONC
70 CFDA 156	CFDA	CFDASED	03/20/92	14:14	dae	SB	CONC
83 CFDA 156	CFDA	CFDASED	03/20/92	14:53	dae	SB	CONC
84 CFDA 156 ag	CFDA	CFDASED	03/20/92	14:55	dae	SB	CONC
4 CFDA 175	CFDA	CFDASED	03/26/92	11:09	dae	SB	CONC
15 CFDA 175	CFDA	CFDASED	03/26/92	11:43	dae	SB	CONC
27 CFDA 175	CFDA	CFDASED	03/26/92	12:25	dae	SB	CONC
28 CFDA 175	CFDA	CFDASED	03/26/92	12:28	dae	SB	CONC
36 CFDA 194	CFDA	CFDASED	03/26/92	12:57	dae	SB	CONC
47 CFDA 194	CFDA	CFDASED	03/26/92	13:32	dae	SB	CONC
61 CFDA 194	CFDA	CFDASED	03/26/92	14:12	dae	SB	CONC

CFDA Sediment Digests - Method Blanks

Lab ID #	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
PDL	20	3	500	2	2.5	10	500
4 CFDA-21	-1.6	0.4	0.2	0.2	-0.2	-2.3	-0.1
15 CFDA-21	-0.4	0.2	1.1	0.1	-0.1	8.7	-0.1
26 CFDA-21	-2.5	-1.4	1.4	0.2	1.4	-0.4	1.1
33 CFDA-39	-2.9	-0.8	1.6	-0.1	-0.1	-3.1	-0.1
44 CFDA-39	1.6	-1.2	4.3	-0.0	-0.1	1.3	1.8
55 CFDA-39	-0.3	-1.1	4.5	-0.1	0.6	3.4	1.5
4 CFDA 59	-2.5	-2.1	0.2	0.0	-0.1	-0.3	-1.0
15 CFDA 59	1.5	-2.2	1.9	0.1	-0.1	2.3	-0.2
27 CFDA 59	0.2	-1.7	3.2	0.2	0.6	3.8	-0.1
36 CFDA 79	-1.4	2.0	1.9	-0.0	-0.6	-0.8	1.0
47 CFDA 79	-0.8	0.5	4.2	-0.1	-0.6	-0.2	1.8
58 CFDA 79	-0.5	0.3	4.1	-0.0	0.0	2.9	0.6
62 CFDA 99	-0.8	-0.1	3.0	-0.1	-0.4	0.1	0.7
73 CFDA 99	-0.3	1.1	2.9	-0.1	-0.2	0.1	1.9
84 CFDA 99	-0.5	-0.8	3.6	-0.0	0.4	1.0	1.7
85 CFDA 99	-0.7	-1.3	3.3	-0.1	0.1	0.0	0.0
4 CFDA 118	-1.4	-0.5	4.8	0.1	1.4	1.8	1.6
15 CFDA 118	-0.4	0.6	12.8	0.2	2.2	5.2	4.7
26 CFDA 118	2.5	-0.3	9.6	0.1	2.7	6.1	4.6
27 CFDA 118	0.6	-1.9	6.2	0.1	2.0	2.5	2.5
33 CFDA 118	-2.7	1.0	-1.0	-0.0	2.4	-0.8	-3.9
34 CFDA 137	-4.0	-0.9	-4.5	-0.0	0.3	-1.5	-5.3
45 CFDA 137	-0.7	-1.4	-3.0	0.0	0.4	-0.6	-5.8
56 CFDA 137	0.1	0.6	-2.9	0.1	1.2	0.5	-3.8
60 CFDA 156	-1.2	1.3	-5.2	-0.0	0.7	-1.2	-5.6
70 CFDA 156	-0.5	0.0	-0.4	-0.0	1.4	1.5	-2.7
83 CFDA 156	-0.3	-1.2	-2.5	0.0	1.9	1.9	-4.3
84 CFDA 156	-1.1	0.1	-4.6	0.0	1.5	-1.1	-5.0
4 CFDA 175	-1.8	-0.2	7.0	0.1	-0.1	-0.1	1.0
15 CFDA 175	2.1	-0.8	8.4	0.1	1.1	0.4	1.2
27 CFDA 175	-0.2	-3.5	8.4	0.1	3.1	0.8	0.8
28 CFDA 175	-2.8	-3.0	7.0	-0.0	2.1	-0.4	-0.1
36 CFDA 194	-1.5	-1.8	2.4	0.1	0.6	-0.7	-2.0
47 CFDA 194	-1.2	-0.5	3.6	0.1	4.9	3.6	-0.8
61 CFDA 194	0.2	-2.0	3.8	0.3	2.4	0.8	1.4

PDL = Project Detection Limit, ppm in sediment @ nominal 1:100 dilution

CFDA Sediment Digests - Method Blanks

Lab ID #	Mn2576	Ni2316	P_2149	Pb2204	Ti3349	Zn2138
PDL	1.5	4		3.5		2
4 CFDA-21	0.0	-0.4	2.5	0.8	-0.3	-0.0
15 CFDA-21	0.3	-0.5	3.2	0.7	-0.3	0.4
26 CFDA-21	0.1	-0.1	11.3	0.8	-0.2	0.6
33 CFDA-39	0.1	-0.1	1.6	-0.1	-0.0	-0.0
44 CFDA-39	0.9	0.3	3.5	0.2	0.1	0.3
55 CFDA-39	0.5	0.3	4.9	0.8	0.1	0.3
4 CFDA 59	-0.0	0.4	-4.4	0.8	-0.0	-0.1
15 CFDA 59	0.2	0.6	-0.9	0.9	-0.1	0.1
27 CFDA 59	0.3	0.7	1.4	1.2	0.0	0.7
36 CFDA 79	0.1	0.2	-2.3	-0.3	0.1	-0.1
47 CFDA 79	0.1	-0.4	3.3	-1.6	0.0	-0.0
58 CFDA 79	0.3	0.2	7.5	0.7	0.1	0.5
62 CFDA 99	0.1	-0.6	8.7	-0.2	0.0	0.2
73 CFDA 99	0.1	-0.4	10.1	0.8	-0.0	0.4
84 CFDA 99	0.2	-0.2	13.6	1.0	0.0	0.6
85 CFDA 99	0.0	0.0	0.1	0.0	0.0	0.0
4 CFDA 118	0.1	-0.1	3.2	-1.6	-0.0	0.3
15 CFDA 118	0.5	-0.3	18.1	0.3	0.2	0.9
26 CFDA 118	0.4	0.1	16.9	2.2	0.4	0.9
27 CFDA 118	0.1	-0.3	16.8	0.0	0.2	0.6
33 CFDA 118	0.1	0.2	2.3	1.9	0.1	0.3
34 CFDA 137	0.2	1.1	-1.0	0.5	-0.1	3.2
45 CFDA 137	0.3	0.9	1.2	1.5	-0.1	3.6
56 CFDA 137	0.3	0.8	1	2.8	0.1	3.7
60 CFDA 156	0.1	-0.1	-0.3	1.2	0.0	0.3
70 CFDA 156	0.5	0.0	7.1	3.3	0.3	0.7
83 CFDA 156	0.3	-0.5	9.3	2.7	0.1	0.9
84 CFDA 156	0.1	-0.2	10.4	2.6	0.1	0.7
4 CFDA 175	0.3	0.3	1.6	-0.1	0.1	0.2
15 CFDA 175	0.5	0.4	7.4	0.2	-0.0	0.7
27 CFDA 175	0.4	0.1	18.8	1.0	0.1	1.0
28 CFDA 175	0.3	0.1	12.4	1.3	-0.1	0.8
36 CFDA 194	0.1	0.3	2.4	1.1	0.0	0.2
47 CFDA 194	0.3	0.7	3.1	2.6	0.2	2.1
61 CFDA 194	0.2	0.7	10.3	3.4	0.2	1.2

PDL = Project Detection Limit, ppm in sediment @ nominal 1:100 dilution

CFDA Sediment Digests - Duplicated Samples

Sample Name	File	Method	Date	Time	OpID	Type	Mode
BC-03	CFDA	CFDASED	02/24/92	10:52	dae	SD	CONC
BC-03 d	CFDA	CFDASED	02/24/92	11:28	dae	SD2	CONC
RPD							
BH-01	CFDA	CFDASED	02/24/92	11:16	dae	SD	CONC
BH-01 d	CFDA	CFDASED	02/24/92	13:26	dae	SD2	CONC
RPD							
CF-01-X	CFDA	CFDASED	02/28/92	14:13	dae	SD	CONC
CF-01-X d	CFDA	CFDASED	02/28/92	14:44	dae	SD2	CONC
RPD							
CF-03-A	CFDA	CFDASED	02/28/92	14:30	dae	SD	CONC
CF-03-A d	CFDA	CFDASED	03/20/92	11:30	dae	SD2	CONC
RPD							
CF-11	CFDA	CFDASED	03/20/92	11:22	dae	SD	CONC
CF-11 d	CFDA	CFDASED	03/20/92	13:24	dae	SD2	CONC
RPD							
CF-36	CFDA	CFDASED	03/20/92	12:41	dae	SD	CONC
CF-36 d	CFDA	CFDASED	03/20/92	14:45	dae	SD2	CONC
RPD							
GC-02-Z	CFDA	CFDASED	02/28/92	11:10	dae	SD	CONC
GC-02-Z d	CFDA	CFDASED	02/28/92	11:51	dae	SD2	CONC
RPD							
RR-09	CFDA	CFDASED	02/28/92	14:03	dae	SD	CONC
RR-09 d	CFDA	CFDASED	02/28/92	13:32	dae	SD2	CONC
RPD							
SB-03-Y	CFDA	CFDASED	03/26/92	13:04	dae	SD	CONC
SB-03-Y d	CFDA	CFDASED	03/26/92	12:15	dae	SD2	CONC
RPD							
SB-13-B	CFDA	CFDASED	03/26/92	13:59	dae	SD	CONC
SB-13-B d	CFDA	CFDASED	03/26/92	14:01	dae	SD2	CONC
RPD							

CFDA Sediment Digests - Duplicated Samples

Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
BC-03	12402.5	84.6	9752.0	0.3	113.6	39607.9	5331.1
BC-03 d	12902.6	85.7	10102.0	0.3	114.9	41308.3	5391.1
RPD	**4.0%**	**1.3%**	**3.5%**	**-0.0%**	**1.1%**	**4.2%**	**1.1%**
BH-01	10300.0	24.1	11200.0	0.6	39.2	24900.0	5400.0
BH-01 d	9740.3	26.5	10689.3	0.4	38.9	23476.5	5114.9
RPD	**-5.6%**	**9.4%**	**-4.7%**	**-41.8%**	**-0.5%**	**-5.9%**	**-5.4%**
CF-01-X	6482.2	36.2	56032.7	2.8	365.1	10587.3	4015.2
CF-01-X d	6807.3	34.8	55277.9	2.8	360.3	10895.6	4058.4
RPD	**4.9%**	**-3.9%**	**-1.4%**	**-1.0%**	**-1.3%**	**2.9%**	**1.1%**
CF-03-A	6917.2	42.9	53378.6	4.9	435.2	11995.2	4308.3
CF-03-A d	6267.5	42.2	54478.2	5.0	435.5	11295.5	4128.3
RPD	**-9.9%**	**-1.6%**	**2.0%**	**2.8%**	**0.1%**	**-6.0%**	**-4.3%**
CF-11	7913.7	63.2	26578.7	4.4	575.0	14588.3	4636.3
CF-11 d	8916.4	60.6	26689.3	4.4	600.0	15593.8	4978.0
RPD	**11.9%**	**-4.3%**	**0.4%**	**0.5%**	**4.2%**	**6.7%**	**7.1%**
CF-36	9538.1	58.6	30693.9	5.0	766.2	15996.8	5258.9
CF-36 d	9416.2	62.8	31287.5	5.1	761.1	16393.4	5227.9
RPD	**-1.3%**	**6.9%**	**1.9%**	**0.6%**	**-0.7%**	**2.4%**	**-0.6%**
GC-02-Z	11333.9	5.4	18094.4	0.4	26.5	15012.4	5080.4
GC-02-Z d	11291.0	4.4	18185.4	0.2	26.3	14988.0	5046.0
RPD	**-0.4%**	**-19.9%**	**0.5%**	**-71.3%**	**-0.7%**	**-0.2%**	**-0.7%**
RR-09	9094.5	8.6	73356.0	-0.1	21.4	15290.8	9664.2
RR-09 d	9436.2	7.5	72171.1	-0.1	21.1	15493.8	9746.1
RPD	**3.7%**	**-13.6%**	**-1.6%**	**-6.9%**	**-1.3%**	**1.3%**	**0.8%**
SB-03-Y	11595.4	768.7	7656.9	30.0	10915.6	37784.9	3818.5
SB-03-Y d	10655.1	767.0	7478.7	27.3	10283.2	36287.7	3588.6
RPD	**-8.5%**	**-0.2%**	**-2.4%**	**-9.5%**	**-6.0%**	**-4.0%**	**-6.2%**
SB-13-B	11904.8	441.2	10504.2	37.2	7190.9	35514.2	4531.8
SB-13-B d	12209.8	437.3	10508.4	37.2	7233.8	35628.5	4583.7
RPD	**2.5%**	**-0.9%**	**0.0%**	**0.1%**	**0.6%**	**0.3%**	**1.1%**

RPD = Relative Percent Difference,
the difference of the two replicates divided by their average

CFDA Sediment Digests - Duplicated Samples

Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Ti3349	Zn2138
BC-03	2141.4	9.7	1750.4	49.0	609.4	359.9
BC-03 d	2137.4	10.6	1870.4	49.9	601.4	364.6
RPD	**-0.2%**	**8.9%**	**6.6%**	**1.8%**	**-1.3%**	**1.3%**
BH-01	1679.0	11.9	2080.0	72.2	283.1	165.5
BH-01 d	1619.4	11.8	2028.0	70.0	281.6	157.2
RPD	**-3.6%**	**-0.9%**	**-2.5%**	**-3.1%**	**-0.5%**	**-5.1%**
CF-01-X	1609.1	8.8	1168.6	72.7	177.5	780.1
CF-01-X d	1582.4	8.5	1159.5	72.4	182.1	771.4
RPD	**-1.7%**	**-3.4%**	**-0.8%**	**-0.5%**	**2.6%**	**-1.1%**
CF-03-A	4045.4	10.2	1259.5	80.2	190.3	1145.5
CF-03-A d	4068.4	9.8	1249.5	79.7	179.2	1155.5
RPD	**0.6%**	**-4.0%**	**-0.8%**	**-0.6%**	**-6.0%**	**0.9%**
CF-11	2218.2	9.9	1388.9	107.9	205.5	1008.2
CF-11 d	2258.1	11.4	1389.4	112.0	231.4	1023.6
RPD	**1.8%**	**14.1%**	**0.0%**	**3.7%**	**11.8%**	**1.5%**
CF-36	3007.4	11.5	1299.7	105.0	228.4	1166.8
CF-36 d	3005.8	11.9	1309.5	110.0	207.6	1169.5
RPD	**-0.1%**	**3.4%**	**0.7%**	**4.6%**	**-9.5%**	**0.2%**
GC-02-Z	527.2	11.5	1183.1	17.7	365.1	68.0
GC-02-Z d	525.4	11.2	1179.1	19.0	360.3	68.2
RPD	**-0.4%**	**-3.0%**	**-0.3%**	**7.0%**	**-1.3%**	**0.2%**
RR-09	590.9	16.2	1029.4	18.2	142.0	65.0
RR-09 d	581.8	15.9	1009.6	16.8	143.2	65.0
RPD	**-1.6%**	**-1.8%**	**-1.9%**	**-8.0%**	**0.9%**	**-0.1%**
SB-03-Y	1999.2	10.4	4478.2	1709.3	437.3	8777.5
SB-03-Y d	1954.1	9.4	4322.4	1648.5	423.7	8704.0
RPD	**-2.3%**	**-9.5%**	**-3.5%**	**-3.6%**	**-3.2%**	**-0.8%**
SB-13-B	2412.0	13.9	3901.6	1150.5	440.7	8466.4
SB-13-B d	2400.9	13.5	3883.1	1140.9	444.3	8426.7
RPD	**-0.5%**	**-2.9%**	**-0.5%**	**-0.8%**	**0.8%**	**-0.5%**

RPD = Relative Percent Difference,
the difference of the two replicates divided by their average

CFDA Sediment Digests - Spiked Samples

Sample Name	File	Method	Date	Time	OpID	Type	Mode
Spike Conc.							
BC-05-X	CFDA	CFDASED	02/24/92	10:58	dae	SS	CONC
BC-05-X s	CFDA	CFDASED	02/24/92	11:37	dae	SS2	CONC
%Rec							
BH-04-Y	CFDA	CFDASED	02/24/92	12:31	dae	SS	CONC
BH-04-Y s	CFDA	CFDASED	02/24/92	13:21	dae	SS2	CONC
%Rec							
BH-07	CFDA	CFDASED	02/24/92	12:47	dae	SS	CONC
BH-07 s	CFDA	CFDASED	02/28/92	11:53	dae	SS2	CONC
%Rec							
BH-08-A	CFDA	CFDASED	02/24/92	12:50	dae	SS	CONC
BH-08-A s	CFDA	CFDASED	02/28/92	13:35	dae	SS2	CONC
%Rec							
CF-22-X	CFDA	CFDASED	03/20/92	12:51	dae	SS	CONC
CF-22-X s	CFDA	CFDASED	03/20/92	14:48	dae	SS2	CONC
%Rec							
CF-30	CFDA	CFDASED	03/26/92	11:32	dae	SS	CONC
CF-30 s	CFDA	CFDASED	03/26/92	14:05	dae	SS2	CONC
%Rec							
CF-35	CFDA	CFDASED	03/20/92	11:24	dae	SS	CONC
CF-35 s	CFDA	CFDASED	03/20/92	13:27	dae	SS2	CONC
%Rec							
CF-43	CFDA	CFDASED	03/20/92	14:05	dae	SS	CONC
CF-43 s	CFDA	CFDASED	03/26/92	12:18	dae	SS2	CONC
%Rec							
LB-03	CFDA	CFDASED	02/28/92	11:31	dae	SS	CONC
LB-03 s	CFDA	CFDASED	02/28/92	14:47	dae	SS2	CONC
%Rec							
RR-07	CFDA	CFDASED	02/28/92	13:58	dae	SS	CONC
RR-07 s	CFDA	CFDASED	03/20/92	11:34	dae	SS2	CONC
%Rec							

CFDA Sediment Digests - Spiked Samples

Sample Name	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
Spike Conc.		**100**		**10**	**100**		
BC-05-X	12807.7	60.0	8285.0	1.0	138.1	31919.1	5213.1
BC-05-X s	12354.1	165.7	8457.0	12.2	247.7	32241.2	5162.6
%Rec		**106%**		**112%**	**110%**		
BH-04-Y	10804.3	15.5	9273.7	0.3	36.0	21208.5	5362.1
BH-04-Y s	11395.4	121.0	9386.2	11.0	139.7	22191.1	5497.8
%Rec		**105%**		**107%**	**104%**		
BH-07	10495.8	27.3	9026.4	0.6	37.8	24490.2	4588.2
BH-07 s	11293.2	127.9	9394.4	11.3	142.6	25984.4	4777.1
%Rec		**101%**		**107%**	**105%**		
BH-08-A	9630.7	36.9	11776.4	0.2	33.2	27245.4	4760.5
BH-08-A s	11402.3	143.0	11802.4	10.6	136.3	28905.8	5131.0
%Rec		**106%**		**104%**	**103%**		
CF-22-X	8206.6	58.9	38130.5	5.4	727.7	14611.7	4863.9
CF-22-X s	9026.4	164.9	39384.2	16.2	843.2	15993.6	5127.9
%Rec		**106%**		**108%**	**115%**		
CF-30	9670.0	157.0	72000.0	7.4	1067.0	21400.0	8580.0
CF-30 s	11313.6	260.3	73388.0	17.6	1162.4	23628.3	9110.9
%Rec		**103%**		**102%**	**95%**		
CF-35	9996.0	101.0	28788.5	5.9	796.5	18292.7	5507.8
CF-35 s	11595.4	201.9	29088.4	16.7	942.0	19792.1	5987.6
%Rec		**101%**		**108%**	**146%**		
CF-43	8751.8	121.0	39007.8	7.4	1251.3	18003.6	5311.1
CF-43 s	9196.3	228.9	38984.4	17.0	1320.5	18692.5	5307.9
%Rec		**108%**		**96%**	**69%**		
LB-03	8434.9	28.8	12392.6	0.9	52.1	15590.6	4367.4
LB-03 s	8281.7	133.0	12302.5	10.8	151.3	15403.1	4290.9
%Rec		**104%**		**99%**	**99%**		
RR-07	9073.6	6.4	79131.6	-0.3	28.6	15006.0	9343.7
RR-07 s	9078.2	106.0	81783.6	9.7	124.1	15496.9	9338.1
%Rec		**100%**		**100%**	**96%**		

%Recovery = conc. measured in spiked sample - conc. measured in original sample
divided by the concentration of spike added

CFDA Sediment Digests - Spiked Samples

Sample Name	Mn2576	Ni2316	P_2149	Pb2204	Ti3349	Zn2138
Spike Conc.	**200**			**50**		**200**
BC-05-X	1577.9	8.4	1010.6	55.3	631.5	350.9
BC-05-X s	1812.9	9.2	1024.5	113.5	614.4	571.9
%Rec	**117%**			**116%**		**110%**
BH-04-Y	909.6	11.3	1560.6	60.1	286.1	165.9
BH-04-Y s	1122.6	11.8	1579.4	112.0	286.3	376.5
%Rec	**106%**			**104%**		**105%**
BH-07	526.3	11.7	1949.2	86.7	270.9	211.0
BH-07 s	749.1	12.6	2028.8	143.9	282.9	427.5
%Rec	**111%**			**114%**		**108%**
BH-08-A	1660.7	12.1	2155.7	81.7	296.6	205.0
BH-08-A s	1864.4	12.7	2190.4	132.0	335.1	413.3
%Rec	**102%**			**101%**		**104%**
CF-22-X	4870.9	11.9	1491.2	103.1	198.9	1046.8
CF-22-X s	5184.9	12.1	1549.4	160.9	204.6	1267.5
%Rec	**157%**			**116%**		**110%**
CF-30	11870.0	15.0	1410.0	150.0	308.7	1757.0
CF-30 s	12334.8	14.9	1451.7	199.2	348.7	1912.3
%Rec	**232%**			**98%**		**78%**
CF-35	2631.9	13.4	1359.5	155.9	206.1	1420.4
CF-35 s	2890.8	13.6	1379.4	210.9	225.5	1633.3
%Rec	**129%**			**110%**		**106%**
CF-43	4002.8	12.5	1410.3	166.0	243.0	1431.3
CF-43 s	4089.4	12.0	1439.4	209.9	253.9	1603.4
%Rec	**43%**			**88%**		**86%**
LB-03	2768.3	14.4	1898.9	53.8	144.3	165.0
LB-03 s	2964.6	13.8	1900.4	100.0	142.2	362.7
%Rec	**98%**			**93%**		**99%**
RR-07	515.2	20.8	853.3	18.4	215.6	64.3
RR-07 s	707.6	21.3	875.8	68.0	207.0	254.2
%Rec	**96%**			**99%**		**95%**

%Recovery = conc. measured in spiked sample - conc. measured in original divided by the concentration of spike added

CFDA Sediment Digests - USGS-SED2 Standard Reference Material

Lab ID #	File	Method	Date	Time	OpID	Type	Mode
SRM **Reported** **True Conc. mean** **± 95% CL**							
25 CFDA-20	CFDA	CFDASED	02/24/92	11:40	dae	R	CONC
53 CFDA-41	CFDA	CFDASED	02/24/92	13:24	dae	R	CONC
26 CFDA 63	CFDA	CFDASED	02/28/92	11:57	dae	R	CONC
57 CFDA 84	CFDA	CFDASED	02/28/92	13:38	dae	R	CONC
83 CFDA 105	CFDA	CFDASED	02/28/92	14:50	dae	R	CONC
25 CFDA 126	CFDA	CFDASED	03/20/92	11:37	dae	R	CONC
55 CFDA 147	CFDA	CFDASED	03/20/92	13:29	dae	R	CONC
82 CFDA 168	CFDA	CFDASED	03/20/92	14:50	dae	R	CONC
26 CFDA 189	CFDA	CFDASED	03/26/92	12:21	dae	R	CONC
60 CFDA 210	CFDA	CFDASED	03/26/92	14:07	dae	R	CONC
Mean							
SD							
%Diff							

CFDA Sediment Digests - USGS-SED2 Standard Reference Material

Lab ID #	Al2373	As1936	Ca3179	Cd2288	Cu3247	Fe2599	Mg2795
SRM							
Reported							
True Conc. mean	8800	144	17000	8.3	1140	22800	5200
± 95% CL	1600	28	1200	1	130	3400	310
25 CFDA-20	6231	162.0	17804	7.3	1166	22004	4681
53 CFDA-41	6829	157.0	17097	7.1	1135	22096	4839
26 CFDA 63	6595	156.8	17695	7.2	1141	22018	4776
57 CFDA 84	6413	153.1	16607	6.7	1093	21108	4592
83 CFDA 105	6921	158.3	17228	6.9	1102	22336	4768
25 CFDA 126	6030	160.0	17200	6.9	1104	21000	4460
55 CFDA 147	7078	157.2	17121	7.2	1159	22727	4926
82 CFDA 168	7086	157.9	17789	7.4	1165	22886	4977
26 CFDA 189	6421	163.0	17203	6.9	1122	21704	4601
60 CFDA 210	6551	161.0	18004	7.2	1140	22605	4781
Mean	6616	159	17375	7.1	1133	22048	4740
SD	325	3	395	0.2	24	637	154
%Diff	-25%	10%	2%	-15%	-1%	-3%	-9%

CFDA Sediment Digests - USGS-SED2 Standard Reference Material

Lab ID #	Mn2576	Ni2316	P_2149	Pb2204	Ti3349	Zn2138
SRM						
Reported						
True Conc. mean	1470	10.8		149		1480
± 95% CL	80	1.6		15		90
25 CFDA-20	1511	10.0	794	150.0	417	1506
53 CFDA-41	1488	10.4	810	151.0	442	1472
26 CFDA 63	1526	10.9	827	154.8	435	1500
57 CFDA 84	1443	9.6	796	146.1	421	1408
83 CFDA 105	1472	10.5	834	149.2	446	1466
25 CFDA 126	1449	9.6	784	150.0	402	1497
55 CFDA 147	1510	10.2	792	154.2	454	1477
82 CFDA 168	1547	10.7	820	156.9	463	1510
26 CFDA 189	1483	10.0	809	147.0	425	1435
60 CFDA 210	1502	10.5	835	155.0	404	1392
Mean	1493	10.2	810	151	431	1466
SD	32	0.4	18	4	20	39
%Diff	2%	-5%		2%		-1%

Appendix D
ICAP Sample Run Scheme

Warmup instrument for at least 1 hour

Begin Run

Profile (check and adjust optical alignment of entrance slit with exit slits)
Standardize with set of five matrix matched standards
Print standardization report

Begin sample analyses

$\left.\begin{array}{l}\text{Standard 6 (composite)}\\ \text{Standard 1 (blank)}\end{array}\right\}$ Verify Standardization

begin sample group
method blank
:
8-10 samples, including QA/QC samples
:
method blank
:
8-10 samples, including QA/QC samples
:
method blank
end sample group

$\left.\begin{array}{l}\text{Std.1 (blank)}\\ \text{Std.6 (composite)}\end{array}\right\}$ Standardization Check[1]

[possibly repeat profile and standardization,
if so repeat Std 6, Std 1 to verify restandardization]
:
another *sample group(s)*
:

$\left.\begin{array}{l}\text{Std.1 (blank)}\\ \text{Std.6 (composite)}\end{array}\right\}$ Standardization End Check[2]

End Sample Analyses

Perform Interelement Interference Check

End Run

---

[1] Perform standardization (continuing calibration) check after every group of 16-20 samples. If acceptable—drift within 5-10% for analytes of interest—continue sample analyses with additional sample groups, checking standardization between groups. If analysis of standards indicates instrument drift is unacceptable then instrument is profiled and standardized again and all samples run since last acceptable standardization check are reanalyzed.

[2] A group of sample analyses is always closed with a method blank and then a standardization check, even when less than 16 samples make up a group.

Appendix E

Sample % Carbon

Carbon Analysis (TC, TIC, TOC)
Total Carbon Replicates
Inorganic Carbon Replicates
Carbon Analysis Standards

CFDA Sediments - Carbon Analysis

Sample	Clark Fork River Miles	% C-TC	% C-TIC	TIC-ppm	% C-TOC
NBS 2704		3.35	0.887	8870	2.47
BC-1		4.63	0.027	265	4.60
BC-2-x		4.82	0.024	242	4.79
BC-2-y		4.84	0.028	279	4.81
BC-2-z		5.79	0.030	299	5.76
BC-3		4.97	0.037	368	4.94
BC-4		4.64	0.022	221	4.62
BC-5-x		5.16	0.023	230	5.14
BC-5-y		4.83	0.022	219	4.81
BC-5-z		5.27	0.026	262	5.24
BC-6-A		6.74	0.038	376	6.71
BC-6-B		6.57	0.037	367	6.53
BH-1		6.15	0.092	919	6.05
BH-1-y		7.90	0.087	869	7.81
BH-1-z		7.05	0.094	936	6.96
BH-2		4.15	0.022	224	4.13
BH-3		4.61	0.057	574	4.55
BH-4-x		6.06	0.202	2021	5.86
BH-4-y		5.30	0.066	656	5.23
BH-4-z		4.97	0.038	383	4.93
BH-5		3.68	0.027	270	3.66
BH-5-y		3.27	0.016	164	3.26
BH-5-z		3.95	0.028	282	3.92
BH-6		6.00	0.281	2812	5.72
BH-7		6.46	0.061	612	6.40
BH-8-A		5.93	0.120	1197	5.81
BH-8-B		5.71	0.125	1245	5.58
BH-9		6.16	0.239	2392	5.92
BH-10		4.62	1.589	15890	3.04
BH-11		4.19	0.281	2813	3.91
BH-12		4.51	0.199	1985	4.31
RR-1		4.11	2.106	21060	2.00
RR-2		3.68	1.822	18219	1.86
RR-3		4.29	2.348	23479	1.94
RR-4-x		3.56	1.862	18623	1.70
RR-4-y		4.28	1.994	19944	2.29
RR-4-z		3.81	1.852	18522	1.95
RR-5-x		3.87	1.873	18726	2.00
RR-5-y		3.62	1.785	17850	1.84
RR-5-z		3.79	1.791	17908	2.00
RR-6		3.37	1.763	17633	1.61
RR-7		5.21	2.280	22801	2.93
RR-8		4.76	2.338	23376	2.43
RR-9		4.84	2.094	20938	2.75
RR-10		5.60	2.200	22000	3.40

TC = Total Carbon
TIC = Total Inorganic Carbon

TOC = Total Organic Carbon, calculated by difference

CFDA Sediments - Carbon Analysis

Sample	Clark Fork River Miles	% C-TC	% C-TIC	TIC-ppm	% C-TOC
CF-55-A	367.6	5.54	0.992	9920	4.55
CF-55-B	367.6	5.51	0.998	9981	4.52
CF-1-x	370.6	6.36	1.459	14594	4.90
CF-1-y	370.6	6.58	1.510	15097	5.07
CF-1-z	370.6	5.69	1.294	12943	4.39
CF-2	372.2	5.77	1.503	15028	4.26
CF-3-A	378.9	5.71	1.413	14131	4.30
CF-3-B	378.9	6.31	1.445	14455	4.86
CF-34	381.2	5.88	1.585	15846	4.30
CF-4	381.6	6.14	1.999	19993	4.14
CF-33	381.7	5.73	1.724	17244	4.01
RC-1	381.8	5.50	0.025	251	5.47
RC-1-y	381.8	4.60	0.017	168	4.58
RC-1-z	381.8	4.74	0.018	185	4.72
RC-2	381.8	4.62	0.049	493	4.57
RC-2-y	381.8	3.52	0.047	467	3.47
RC-2-z	381.8	6.32	0.029	293	6.29
RC-3	381.8	6.65	0.071	713	6.58
RC-3-y	381.8	6.90	0.022	217	6.88
RC-3-z	381.8	8.03	0.022	216	8.00
RC-4	381.8	6.67	0.026	259	6.65
RC-5	381.8	8.03	0.028	278	8.01
RC-6	381.8	7.84	0.025	250	7.81
CF-32	381.9	5.90	1.216	12158	4.68
CF-31	382.1	3.79	0.459	4585	3.33
CF-5	382.2	5.49	1.361	13615	4.12
CF-6	387.1	4.31	1.587	15872	2.72
CF-6-y	387.1	5.43	1.244	12440	4.18
CF-6-z	387.1	5.59	0.571	5712	5.02
CF-7	391.4	6.39	1.282	12824	5.11
CF-54	395.9	5.19	0.886	8860	4.30
CF-8	398	3.42	0.679	6792	2.74
CF-9	402.9	5.06	0.985	9853	4.08
CF-10	408.8	4.59	0.876	8762	3.71
CF-13-x	409.6	4.41	1.909	19090	2.50
CF-13-y	409.6	4.89	0.776	7762	4.11
CF-13-z	409.6	4.10	0.720	7199	3.38
CF-14	415.5	4.30	0.855	8549	3.45
CF-11	416.4	3.66	1.509	15092	2.15
CF-35	416.8	4.88	0.610	6098	4.27
CF-15	417.2	3.99	0.817	8174	3.18
CF-15-y	417.2	3.51	0.438	4381	3.07
CF-15-z	417.2	4.40	0.570	5702	3.83
FC-1-x	417.6	4.28	0.465	4647	3.82
FC-1-y	417.6	4.57	0.491	4912	4.08
FC-1-z	417.6	4.23	0.418	4178	3.81

CFDA Sediments - Carbon Analysis

Sample	Clark Fork River Miles	% C-TC	% C-TIC	TIC-ppm	% C-TOC
FC-2	417.6	4.15	0.755	7550	3.40
FC-3	417.6	3.94	0.446	4460	3.50
FC-3-y	417.6	3.63	0.269	2691	3.36
FC-3-z	417.6	3.35	0.259	2588	3.09
CF-36	417.65	4.68	0.693	6931	3.98
CF-51	417.65	4.34	0.672	6720	3.67
CF-37	418	1.83	0.225	2251	1.60
CF-12	418.5	4.91	0.850	8503	4.06
CF-21	424.6	4.69	0.742	7420	3.95
CF-22-x	429.3	6.22	0.932	9320	5.29
CF-22-y	429.3	5.85	0.980	9797	4.87
CF-22-z	429.3	5.50	0.839	8389	4.66
CF-53	431.7	5.28	0.716	7163	4.57
CF-20	434.3	5.52	0.981	9814	4.54
CF-38	435.6	5.85	0.935	9346	4.92
CF-39	435.8	5.20	0.882	8821	4.31
GC-1	435.8	4.32	0.030	300	4.29
GC-2-x	435.8	3.92	0.220	2200	3.70
GC-2-y	435.8	4.24	0.207	2070	4.03
GC-2-z	435.8	4.13	0.222	2218	3.91
GC-3	435.8	3.78	0.265	2653	3.51
CF-40	435.9	5.51	0.961	9611	4.55
CF-41	436.2	5.80	0.897	8968	4.91
CF-19	436.4	4.79	0.946	9459	3.85
CF-18-A	438.7	4.96	0.997	9970	3.96
CF-18-B	438.7	4.94	0.938	9379	4.01
CF-52-x	442	5.70	0.856	8561	4.84
CF-52-y	442	5.88	0.894	8939	4.98
CF-52-z	442	5.62	0.886	8858	4.74
CF-17	444.5	5.19	0.715	7154	4.48
CF-42	444.8	4.08	0.512	5121	3.57
CF-43	445.2	5.41	0.867	8666	4.54
LB-1	445.7	6.50	0.319	3194	6.18
LB-2-x	445.7	4.58	0.172	1719	4.41
LB-2-y	445.7	5.73	0.159	1590	5.57
LB-2-z	445.7	5.60	0.167	1672	5.43
LB-3	445.7	6.33	0.162	1616	6.17
CF-44	445.8	4.13	0.096	958	4.04
CF-45	446.2	3.99	0.668	6680	3.32
CF-16	447	5.65	1.025	10249	4.63
CF-46-A	451.4	2.34	0.403	4030	1.94
CF-46-B	451.4	2.81	0.397	3971	2.41
CF-23	453.8	5.54	1.215	12147	4.32
CF-47	456.5	4.01	0.854	8538	3.16
CF-25	461.8	3.81	0.581	5808	3.23

CFDA Sediments - Carbon Analysis

Sample	Clark Fork River Miles	% C-TC	% C-TIC	TIC-ppm	% C-TOC
CF-24	465.6	6.73	1.383	13826	5.35
CF-27	468.7	5.16	0.963	9629	4.20
CF-48-A	470.4	6.85	0.692	6920	6.15
CF-48-B	470.4	6.57	0.642	6415	5.93
CF-26	475.3	5.71	1.396	13960	4.32
CF-49-y	477.2	5.50	1.513	15135	3.99
CF-49-z	477.2	5.45	1.423	14231	4.03
CF-28	478.6	6.50	1.674	16744	4.82
CF-30	481.9	6.08	2.100	21003	3.98
CF-50-x	482.4	6.58	2.641	26410	3.94
CF-50-y	482.4	6.54	2.316	23160	4.22
CF-50-z	482.4	6.19	2.369	23688	3.82
CF-29	483.4	6.67	3.314	33140	3.35
SB-1	489	2.37	0.507	5072	1.86
SB-1-y	489	3.34	0.482	4815	2.86
SB-1-z	489	5.60	1.787	17873	3.81
SB-13-A	491.6	5.20	0.125	1246	5.08
SB-13-B	491.6	4.79	0.102	1017	4.69
SB-12	492.6	6.32	0.063	625	6.25
SB-2-A	494.5	6.69	0.065	652	6.62
SB-2-B	494.5	6.82	0.062	620	6.75
SB-5-y	495	7.37	0.065	649	7.30
SB-5-z	495	7.85	0.059	589	7.79
SB-9	497	5.37	0.043	426	5.33
SB-8	497.7	5.09	0.040	403	5.05
SB-10	498.5	4.17	0.036	360	4.13
SB-11	499.3	4.79	0.039	389	4.75
SB-3-x	500	5.19	0.041	411	5.15
SB-3-y	500	4.22	0.041	409	4.18
SB-3-z	500	4.00	0.038	385	3.96
SB-7	502.3	3.36	0.045	446	3.32
SB-4	504	2.69	0.018	177	2.67
SB-6-x	506.1	4.84	0.023	226	4.81
SB-6-y	506.1	4.19	0.037	372	4.15
SB-6-z	506.1	4.24	0.017	172	4.23

CFDA Sediments - Total Carbon Replicates

Sample	%C	RPD	RPD avg	Mean %C	STD %C	RSD %
FC-3-z	3.134	17.65	12.98	3.35	0.22	6.59
FC-3-z	3.687	14.00				
FC-3-z	3.171	7.30				
FC-3-z	3.403					
CF-5	5.841	5.53	3.53	5.49	0.22	4.10
CF-5	5.518	4.40				
CF-5	5.275	0.67				
CF-5	5.311					
RR-7	5.138	0.70	1.14	5.21	0.05	1.05
RR-7	5.173	2.00				
RR-7	5.277	0.70				
RR-7	5.240					
CF-52-z	5.635	3.38	3.13	5.62	0.13	2.24
CF-52-z	5.825	5.50				
CF-52-z	5.505	0.51				
CF-52-z	5.532					
CF-51	4.124	6.69	2.38	4.34	0.12	2.86
CF-51	4.400	0.24				
CF-51	4.411	0.21				
CF-51	4.420					
CF-19	4.873	1.90	3.08	4.79	0.10	2.11
CF-19	4.781	2.17				
CF-19	4.884	5.18				
CF-19	4.631					
RC-1-y	4.486	2.38	1.35	4.60	0.07	1.56
RC-1-y	4.593	1.55				
RC-1-y	4.664	0.13				
RC-1-y	4.658					
SB-2-A	6.714	0.35	1.48	6.69	0.06	0.92
SB-2-A	6.690	1.54				
SB-2-A	6.587	2.53				
SB-2-A	6.754					
SB-5-z	7.903	1.35	0.73	7.85	0.04	0.51
SB-5-z	7.797	0.40				
SB-5-z	7.827	0.45				
SB-5-z	7.862					

CFDA Sediments - Total Carbon Replicates

Sample	%C	RPD	RPD avg	Mean %C	STD %C	RSD %
RR-4-y	4.171	4.07	3.84	4.28	0.09	2.19
RR-4-y	4.340	2.95				
RR-4-y	4.212	4.50				
RR-4-y	4.402					
RC-6	7.762	0.18	1.24	7.83	0.11	1.42
RC-6	7.748	0.75				
RC-6	7.806	2.79				
RC-6	8.024					
SB-3-y	4.535	3.78	7.33	4.22	0.25	6.01
SB-3-y	4.363	11.49				
SB-3-y	3.862	6.71				
SB-3-y	4.121					
BH-3	4.775	6.09	3.74	4.61	0.11	2.40
BH-3	4.484	3.16				
BH-3	4.626	1.97				
BH-3	4.535					
BC-6-A	6.800	1.85	1.20	6.74	0.05	0.80
BC-6-A	6.674	0.47				
BC-6-A	6.705	1.28				
BC-6-A	6.791					
CF-28	6.602	2.02	5.95	6.50	0.23	3.52
CF-28	6.735	9.09				
CF-28	6.123	6.73				
CF-28	6.535					
CF-49-y	5.485	2.89	3.03	5.50	0.09	1.64
CF-49-y	5.643	4.45				
CF-49-y	5.392	1.77				
CF-49-y	5.488					
CF-26	5.816	0.69	3.92	5.72	0.15	2.60
CF-26	5.856	6.54				
CF-26	5.474	4.52				
CF-26	5.721					
BH-5	3.702	1.32	2.11	3.68	0.04	1.07
BH-5	3.653	2.38				
BH-5	3.740	2.62				
BH-5	3.642					

CFDA Sediment - Inorganic Carbon Replicates

Sample	%C	RPD	RPD avg	Mean %C	STD %C	RSD %
LB-2-y	0.155	3.60	1.49	0.16	0.00	1.62
LB-2-y	0.160	0.13				
LB-2-y	0.160	0.76				
LB-2-y	0.161					
CF-29	3.223	9.01	5.60	3.31	0.12	3.51
CF-29	3.513	6.63				
CF-29	3.280	1.15				
CF-29	3.242					
CF-45	0.658	2.67	2.59	0.67	0.01	1.39
CF-45	0.676	2.23				
CF-45	0.661	2.87				
CF-45	0.680					
CF-51	0.667	8.27	11.06	0.67	0.06	8.90
CF-51	0.612	4.46				
CF-51	0.640	20.45				
CF-51	0.770					
CF-50-y	2.395	3.52	7.07	2.32	0.10	4.20
CF-50-y	2.310	6.57				
CF-50-y	2.159	11.13				
CF-50-y	2.399					
CF-50-x	2.626	1.40	2.01	2.64	0.04	1.66
CF-50-y	2.589	1.91				
CF-50-x	2.639	2.72				
CF-50-x	2.710					
CF-15-y	0.443	1.13	0.71	0.44	0.00	0.72
CF-15-y	0.438	0.73				
CF-15-y	0.435	0.26				
CF-15-y	0.436					
CF-22-x	0.936	0.88	1.35	0.93	0.01	0.72
CF-22-x	0.928	1.35				
CF-22-x	0.941	1.83				
CF-22-x	0.923					

CFDA Sediment - Inorganic Carbon Replicates

Sample	%C	RPD	RPD avg	Mean %C	STD %C	RSD %
SB-10	0.038	6.64	3.62	0.04	0.00	2.79
SB-10	0.035	0.64				
SB-10	0.035	3.58				
SB-10	0.037					
SB-6-x	0.023	2.64	6.63	0.02	0.00	3.57
SB-6-x	0.022	8.99				
SB-6-x	0.024	8.27				
SB-6-x	0.022					
BH-5	0.026	16.05	10.93	0.03	0.00	6.94
BH-5	0.030	6.89				
BH-5	0.028	9.86				
BH-5	0.025					
BH-10	1.677	9.27	6.63	1.59	0.06	3.87
BH-10	1.522	6.12				
BH-10	1.615	4.49				
BH-10	1.542					
BC-5-x	0.024	1.85	4.49	0.02	0.00	4.92
BC-5-x	0.024	0.37				
BC-5-x	0.024	11.25				
BC-5-x	0.021					
RR-5-y	1.806	1.23	2.21	1.79	0.02	1.34
RR-5-y	1.784	2.07				
RR-5-y	1.747	3.32				
RR-5-y	1.805					
CF-18-A	0.995	0.03	0.15	1.00	0.00	0.19
CF-18-A	0.995	0.25				
CF-18-A	0.998	0.17				
CF-18-A	1.000					
FC-3	0.472	23.46	18.93	0.45	0.05	10.95
FC-3	0.361	32.18				
FC-3	0.477	1.13				
FC-3	0.472					

CFDA Sediments - Carbon Analysis Standards

TOTAL CARBON

Standard	Nominal	Measured
CaCO3 std	12.00	11.983
CaCO3 std		12.373
CaCO3 std		12.365
CaCO3 std		12.378
CaCO3 std		12.066
CaCO3 std		11.573
CaCO3 std		11.789
CaCO3 std		12.478
CaCO3 std		12.099
CaCO3 std		12.076
CaCO3 std		12.201
CaCO3 std		12.348
CaCO3 std		11.950
CaCO3 std		12.204
CaCO3 std		11.700
CaCO3 std		11.659
CaCO3 std		11.435
CaCO3 std		11.961
CaCO3 std		12.311
CaCO3 std		11.381
CaCO3 std		12.328
CaCO3 std		12.073
CaCO3 std		12.257
CaCO3 std		12.113
CaCO3 std		12.024
CaCO3 std		12.363
CaCO3 std		11.913
CaCO3 std		11.045
CaCO3 std		12.000
CaCO3 std		12.287
CaCO3 std		11.920
CaCO3 std		11.973
CaCO3 std		12.204
CaCO3 std		12.330
CaCO3 std		12.104
CaCO3 std		11.968
CaCO3 std		11.554
CaCO3 std		11.680
CaCO3 std		11.983
CaCO3 std		12.066
CaCO3 std		11.999
CaCO3 std		11.926
CaCO3 std		10.992
CaCO3 std		12.199
CaCO3 std		12.277
CaCO3 std		12.162
CaCO3 std		12.066
CaCO3 std		12.017

Mean	12.003
STDev	0.325
RSD	2.71%

Standard	Nominal	Measured
NBS 2704	3.364	3.424
NBS 2704		3.191
NBS 2704		3.341
NBS 2704		3.362
NBS 2704		3.265
NBS 2704		3.242
NBS 2704		3.278
NBS 2704		3.309
NBS 2704		3.327
NBS 2704		3.225
NBS 2704		3.431
NBS 2704		3.416
NBS 2704		3.418
NBS 2704		3.388
NBS 2704		3.267
NBS 2704		3.296
NBS 2704		3.284
NBS 2704		3.351
NBS 2704		3.254
NBS 2704		3.394
NBS 2704		3.411
NBS 2704		3.287
NBS 2704		3.343
NBS 2704		3.367
NBS 2704		3.398
NBS 2704		3.452
NBS 2704		3.381
NBS 2704		3.641
NBS 2704		3.457
NBS 2704		3.222
NBS 2704		3.403
NBS 2704		3.356
NBS 2704		3.581
NBS 2704		3.233

Mean	3.351
STDev	0.098
RSD	2.91%

CFDA Sediments - Carbon Analysis Standards

INORGANIC CARBON

Standard	Nominal	Measured
CaCO3 std	12.00	12.337
CaCO3 std		11.826
CaCO3 std		12.221
CaCO3 std		12.372
CaCO3 std		11.990
CaCO3 std		12.132
CaCO3 std		11.851
CaCO3 std		12.209
CaCO3 std		12.201
CaCO3 std		12.434
CaCO3 std		12.318
CaCO3 std		12.324
CaCO3 std		12.149
CaCO3 std		12.053
CaCO3 std		12.257
CaCO3 std		12.252
CaCO3 std		12.207
CaCO3 std		12.289
CaCO3 std		12.130
CaCO3 std		12.121
CaCO3 std		12.274
CaCO3 std		12.069
CaCO3 std		12.310
CaCO3 std		12.153
CaCO3 std		11.928
CaCO3 std		12.220
CaCO3 std		12.032
CaCO3 std		11.847
CaCO3 std		11.869
CaCO3 std		11.812
CaCO3 std		12.020
CaCO3 std		12.079
CaCO3 std		11.584
CaCO3 std		12.083
CaCO3 std		12.263
CaCO3 std		11.894
	Mean	12.114
	STDev	0.189
	RSD	1.56%

Standard		Measured
NBS 2704		0.901
NBS 2704		0.875
NBS 2704		0.881
NBS 2704		0.884
NBS 2704		0.888
NBS 2704		0.869
NBS 2704		0.873
NBS 2704		0.883
NBS 2704		0.903
NBS 2704		0.883
NBS 2704		0.903
NBS 2704		0.895
NBS 2704		0.887
NBS 2704		0.880
NBS 2704		0.898
NBS 2704		0.879
NBS 2704		0.892
NBS 2704		0.881
NBS 2704		0.888
NBS 2704		0.883
NBS 2704		0.860
NBS 2704		0.898
NBS 2704		0.899
NBS 2704		0.889
NBS 2704		0.891
NBS 2704		0.902
NBS 2704		0.887
NBS 2704		0.871
NBS 2704		0.906
	Mean	0.887
	STDev	0.011
	RSD	1.26%